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SLASH PINE

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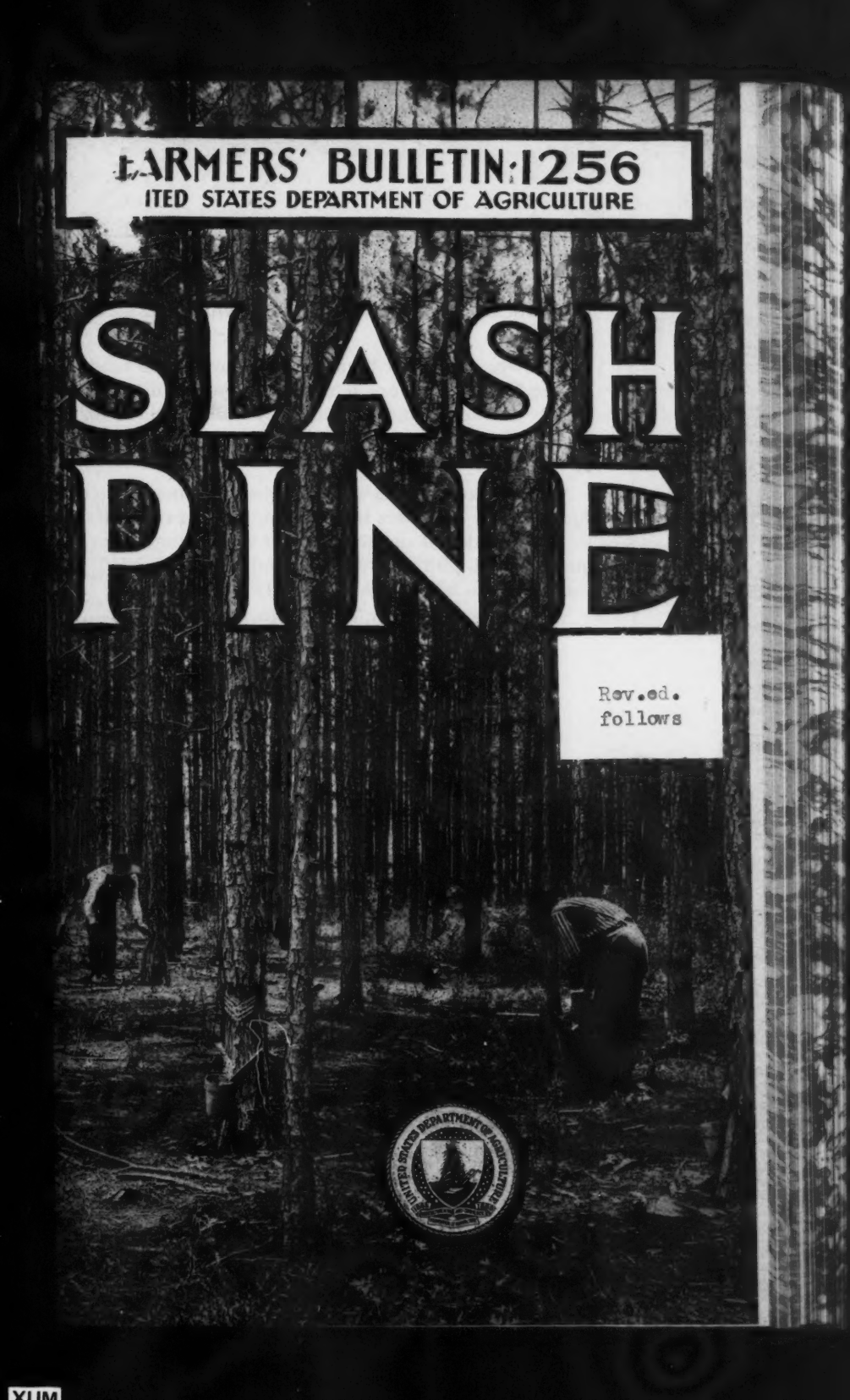

SLASH PINE grows rapidly and yields revenue in turpentine gum at an early age while it is growing timber.

Farmers and other owners of cut-over pine lands in the Gulf region are deriving a good profit from poorly drained, "barren" lands by utilizing them for the grazing of live stock and the production of turpentine and timber.

Well-stocked stands of slash pine produce timber for ordinary purposes in 30 years, at the rate of 100 to 250 board feet an acre a year on average poor-quality land, and on average good situations at the rate of 300 to 500 board feet yearly.

Slash pine can be profitably grown in the South on poor and wet lands.

There are millions of acres in unimproved parts of farms and in cut-over lands that are profitless for agriculture but suitable for the production of timber and naval stores.

By proper methods of cutting and protection, southern pine forests can be perpetually renewed and kept continuously productive.

Young pine is valuable.

Contribution from the Forest Service
WILLIAM B. GREELEY, Forester
Washington, D. C. May, 1922

The picture on the front cover is second-growth slash pine in southern Georgia being worked for turpentine

SLASH PINE.

WILBUR R. MATTOON, *Forest Examiner.*

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SLASH PINE is one of the most profitable timber trees of the South Atlantic and the Gulf States. The old growth, which is being extensively cut, is sold without discrimination along with longleaf pine. Second-growth slash pine, following the cutting of the original forest, has spread rapidly over large areas of flatlands and low uplands of the region. It has been particularly aggressive in establishing itself on old fields and other idle or waste lands about farms and towns. A reliable lumber authority recently estimated that propably not less than 90 per cent of the total amount of sap-pine cut for railroad ties in southern Georgia and northern Florida consists of this species.

Slash pine grows rapidly and at an early age produces turpentine and rosin, as well as timber of high commercial value. Its wood is the heaviest, hardest, and strongest of all pines of the United States, and its yield of crude turpentine is the largest of any of our native trees. Thus slash pine has come to be important in the young or second-growth forests of the South Atlantic and Gulf Coastal Plain because of its good seed production, rapid growth, and ability to grow in dense stands on poorly drained soils. In the economic development now well under way in the South, slash pine is already playing no small part in bringing nonagricultural lands into their most profitable use.

HOW TO RECOGNIZE SLASH PINE.[1]

Slash or "yellow slash" pine was formerly referred to in forestry literature as Cuban pine. In South Carolina and Georgia the original-growth slash pine is sometimes called "rosemary," a name applied, however, in different sections to large trees of several other species of pines. In its younger stages on abandoned fields it is somewhat widely known as "oldfield," and even as "shortleaf" pine.

FIG. 1.—Light orange-colored plates in the bark of mature trees serve to distinguish slash pine from all others. The turpentine workers, though unfamiliar with the botanical features, unmistakably identify this pine by its bark, which they associate with the free-flowing resin qualities of the tree.

Because of the general resemblance of young slash pine to loblolly pine and of the mature slash pine to longleaf pine, considerable difficulty is experienced by persons unfamiliar with the southern pine forest in differentiating the species. However, slash pine is not difficult to identify if one possesses the essential information regarding the foliage, cones (burrs), and bark.

The bark is irregularly divided into thin, dark red-brown scales. Young trees have thicker bark than old ones. The bark of the mature tree has orange-colored scales (fig. 1, and back cover).

The cones are egg-shaped and average 3 to 5 inches in length and, when closed, about 2 inches in width. A small prickle is borne on the lustrous or varnished brown end of the cone scale. (Fig. 2.)

[1] The botanical name is *Pinus caribaea* Morelet. The name formerly accepted was *Pinus heterophylla* Sudworth.

In the lower Florida Peninsula and close along the coasts somewhat north, a form of slash pine grows which by some botanists is believed to be a distinct species called *Pinus cubensis* Griseb. The tree grows on well-drained upland soil and produces gum in less quantity than the more northern form.

The leaves grow in clusters or bundles of 2 and 3, usually with more of the 2-leaved clusters. They are stout and mostly 8 to 12 inches long, and the color is dark, rich green. (Fig. 2.)

The terminal bud is large, reddish brown in color, and in the spring elongates into a straight, stout, light-gray "candle" about the thickness of a large pencil. Longleaf pine, in distinction, has a similar but larger bud elongating into a light-gray "candle," an inch or over in diameter.

The leaf of slash pine is intermediate in length between that of loblolly and longleaf and darker green than either. Both loblolly and longleaf bear foliage with 3 leaves in a cluster. The foliage of slash pine is more dense than that of longleaf and, in the Gulf region, than that of loblolly, which is of a bluish or grayish cast. (Fig. 3.) The cone averages larger than that of loblolly and smaller than longleaf.

The main characteristics by which slash pine is identified are the orange-colored bark plates on the mature tree; the 2 and 3 leaf cluster of heavy, dark-green foliage; the slender prickle on the cone, pointing straight or slightly curved upward on the lustrous-brown end of the cone scale; and the early spring "candle" or shoot, of slash pine, which is light gray, erect, and about one-half inch in diameter.[2]

FIG. 2.—Cone or "burr," two leaf clusters, and a cone scale of slash pine. The ends of the cone scales are plump, rounded, lustrous brown, and bear a small prickle. At the base of each scale two seeds are borne, each with an ample wing for wide dispersal. Leaf bundles of slash pine contain either two leaves or three leaves in a cluster.

Mature trees, or "old growth," of slash pine rise to heights of 80 to 150 feet, with clear lengths of 40 to 70 feet. Diameters of trunks range from 2 to 3 feet, measured at breastheight, or 4½ feet from the

[2] The spring shoot of loblolly is grayish green, slender, and often curved or drooping instead of erect.

ground.[3] The trunk is straight and commonly has more basal swell than longleaf pine.

The numerous medium-sized limbs form a somewhat dense crown of rounded or umbrella-shaped outline. The young tree is noticeably

FIG. 3.—The heavy foliage of slash pine (on the right) in contrast with the thinner foliage of loblolly pine on the left, in South Carolina, where the ranges of these two pines meet and overlap.

straight, with a narrow pyramidal crown of heavy, dark-green foliage above a clean trunk. Slash pine has been pronounced by an eminent tree authority as the handsomest of the North American pines.

[3] Unless otherwise stated, all diameters referred to throughout this bulletin are based on measurements at breastheight.

Trees that have reached growth maturity are usually about 100 years old, although many trees live for 150 years, and some more than 200 years.

RANGE AND DISTRIBUTION.

The range of slash pine extends from about Charleston, S. C., westward through southern Georgia, Alabama, Mississippi, and south-

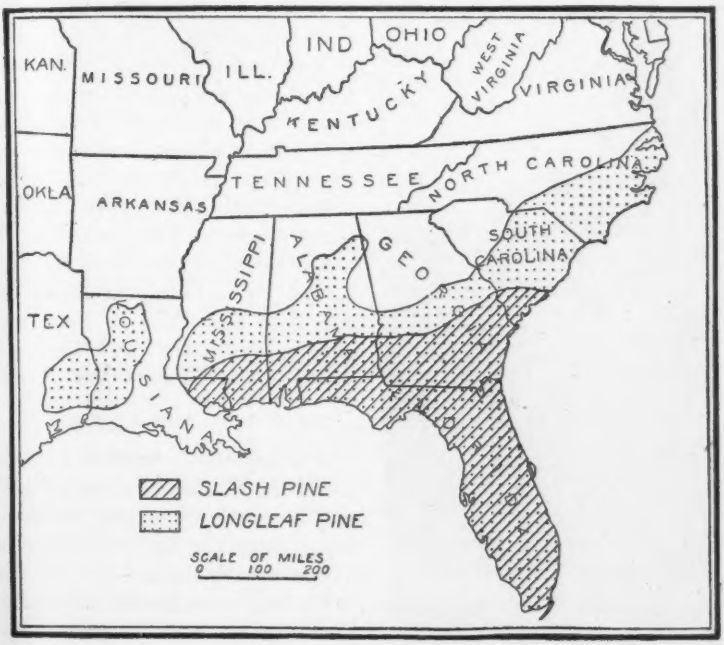

FIG. 4.—The botanical range of slash pine extends from South Carolina west to the Mississippi River (shown by diagonal shading) and overlaps a considerable area of the wider range of longleaf pine (shown by dots).

eastern Louisiana to the Mississippi River, and southward nearly to the southern extremity of Florida. (Fig. 4.) Slash pine is commercially important over its whole range, and over the southern part of the Florida Peninsula it is the chief pine of commercial importance.

In the original forest, confined mostly to the poorly drained flatlands and borders of swamps and bodies of fresh water, slash pine became released with the extensive cutting of the forest, in much the same way as loblolly pine farther north, and it is now spreading widely over lands formerly dominated by longleaf pine. It is found growing on a wide variety of situations, excepting dry, deep, sandy

ridges. On the wire-grass and palmetto flats it is often the only second-growth species of pine. It is aggressively taking lands where some fire protection is afforded, such as wet flatland, abandoned fields, and unused corners about farms and towns and along fence rows, railroad cuts, and embankments (fig. 5). Slash pine thrives in sandy loam soils in poorly drained situations, and is found generally on the wet, mucky soils of bays, ponds, and swamps. It will tolerate a highly acid condition in the surface soil, and a calcareous substratum does not appear to be unfavorable to its growth. On soils with hardpan at shallow depths the tree appears to be somewhat dwarfed in size. It is absent from the very dry, deep sands of the "pine-barren" hills, such as are found in parts of western Florida and southern Mississippi; but even in those sections it is locally abundant on wet flats and close to lakes and streams, and in the numerous ponds scattered all over the Coastal Plain.

FIG. 5.—Vigorous slash pine 15 years old, on high rolling hill land in Telfair County, Ga., 125 miles from the coast.

SLASH PINE AND LIVE STOCK.

A considerable number of owners in the South are deriving good profits from low-priced lands by using them for the production of live stock and timber.

If fire is excluded, the range yields more of the tender annual grasses and legumes[4] which are more nutritious than the hardy perennials like wire and broomsedge grasses, and the influence of the protective soil cover stimulates tree growth to a marked degree. If the timber in the forest pasture becomes too dense, the owner has an easy remedy for the situation by first working the larger trees for turpentine and then cutting them for lumber, ties, posts, pulpwood, or firewood. Open stands of slash pine, with 75 to 150 trees an acre measuring up to 10 inches on the stump, induce a rapid growth of the individual tree and admit a good growth of grass. In such

[4] Department of Agriculture Bulletin 827, "The Cut-Over Pine Lands of the South for Beef Cattle Production." 1921.

stands more turpentine per tree is yielded than in overcrowded ones, and the grazing of live stock can be carried on successfully.

Second-growth slash-pine stands, 20 to 40 years old, frequently contain from 80 to 100 trees to an acre. At 20 cents a cup, less than the price received in 1919 for turpentine rights on the Florida National Forest, such stands would be worth for turpentine $20 to $25, and with pine stumpage at $5 a thousand the timber would be worth $25 to $30, or a total value of $40 to $50 an acre. This represents a gross return in 30 years of $1.50 to about $2 an acre yearly. All observations and experience in such older sections of the country, as New England, indicate that good financial returns may be derived in relatively short periods from second-growth southern forests if handled under a proper system of protection, turpentining, and cutting.

A SUCCESSFUL TURPENTINE FARMER.

In Clinch County, Ga., a farmer owns about 600 acres of cut-over timberland. Of this, 150 to 200 acres are suitable for improving for cultivation and the remainder is of such character as to be more profitable for live-stock grazing and timber growing. The owner believes that by supplementing the grazing with feed raised for winter use he can maintain on his lands a fair-sized herd of cattle, but he is looking forward with particular interest to the additional profit that will be derived from growing and utilizing his timber to the best advantage.

For a number of years this forester-farmer has been carefully cupping his own timber and selling the gum instead of selling the timber or leasing the turpentine rights. Meanwhile, as an essential part of farm management, he has been keeping fires out, so far as possible, and urging his neighbors and the public as a matter of community welfare, to lend their aid toward fire prevention. As a result of this progressive spirit, and in addition to the income derived from turpentine and the sale of 1,500,000 feet of bled timber, in 1918, this farm operator now has on his place a large amount of thrifty young slash and longleaf pine, which, if handled in the same manner, means a continuous income with a substantial yearly increase for a number of years and an enhancing value of the property. The plan is working out so successfully that the owner is acquiring more land as an addition to his turpentine farm.

In August of the first season (1919) this farmer reported that chipping once a week each thousand cups had yielded a dip of crude gum of about 7 barrels of 280-pounds capacity every 4 weeks. With an average of 6 dippings for the first season, the yield was 42 barrels per 1000 cups. The trees are being worked for 3 to 5 years, or an average of 4 years. The flow of gum each season amounts to about

a barrel less at each dipping. At this rate, 1,000 cups yield 42, 36, 31, and 26 barrels of gum, respectively, for the four years, or a total of 135 barrels of gum. This does not include the "scrape," for which no figures are available. At $5 a barrel for crude gum, the current local price in August, 1919, the dip from 1,000 cups was worth $210, $180, $155, and $130, respectively, for the successive seasons for working, or an aggregate value of $675.

After the trees have been turpentined for a period of 3 to 5 years they are sold for ties or lumber. In 1919 the timber in the standing trees brought from 15 to 25 cents each for ties, the equivalent of $3.50 to $4 a thousand feet for saw timber.

As a measure of protection, the owner, in the late fall, rakes a space 18 to 24 inches in width around each cupped tree, and, as soon after rain as the grass becomes sufficiently dry for a slow fire, burns over the ground. In order to lessen damage, the fire is handled against the wind, and as a further protective measure, burning is frequently done at night. It has been found by careful observation and experience that the period from January 1 to February 15 is the most favorable time of the year for such burning. Under these conditions of light burning the flames, as a rule, do not rise high enough to injure the boughs of the small pines, and as a result the owner, while deriving a continuous profit from it, is making a notable success of perpetuating the forest.

RATE OF GROWTH.

Slash pine is one of the most rapid growing and earliest maturing forest trees. Growth in height is particularly rapid during the younger stages, up to about 20 years of age. In the first year, seedlings commonly reach 8 to 12 inches in height. At 5 years old slash pine in stands ranges mostly from 6 to 10 feet in height. During the next 5 to 10 years an upward growth of 2 to 3 feet yearly is not uncommon. Probably no other eastern species of conifer equals slash pine in its very early heighth growth. When about 25 to 35 years of age the rate of upward growth of slash pine slackens, apparently being about the same as that of longleaf on similar grades of situation. Growth in diameter is also rapid. In fully stocked stands the increase in diameter is relatively slow as compared with that of trees standing a considerable distance apart. (Fig. 6.) Table 1 shows for different ages the average height and diameter of slash pine trees and the number of trees per acre growing in well-stocked stands. The range in size at any given age varies chiefly with the favorableness of the situation in which the tree or the stand of trees is growing, and with the tree density or number of trees growing on a specified area.

FIG. 6.—The adaptability of slash pine to heavy wet soils enables it to grow rapidly even in dense stands, thus producing a large amount of timber in a relatively short period.

TABLE 1.—*Average growth in height and diameter of trees and number of trees per acre, growing in well-stocked, even-aged slash-pine stands on various qualities of land.*[1]

Age of stand.	Height.			Diameter [a] (breastheight).			Approximate number of trees per acre.
	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.	
Years.	*Feet.*	*Feet.*	*Feet.*	*Inches.*	*Inches.*	*Inches.*	
10	34	25	10	4.0	2.5	1.0	1,000 to 2,500.
15	45	35	25	6.5	4.7	3.0	700 to 1,800.
20	55	45	35	8.5	6.3	4.0	500 to 1,200.
25	64	54	44	9.5	7.5	5.5	300 to 900.
30	68	60	50	10.5	8.3	6.0	200 to 650.
35	74	64	55	11.0	9.0	7.0	150 to 500.
40	78	68	59	12.0	10.0	8.0	125 to 400.
45	81	72	63	12.5	10.5	8.5	100 to 325.
50	84	74	65	13.0	11.0	9.0	90 to 275.

[a] Diameters measured at breastheight, or 4½ feet above the ground.

The individual trees in well-stocked stands at 15 years of age, for example, usually range from 25 to 45 feet in height and 3 to 6 inches in diameter. (Table 1.) At 30 years, an age when large amounts of slash pine is merchantable, the trees range from 6 to over 10 inches in diameter and 50 to 68 feet in height. If, however, the trees have grown more openly, with the fullest space for development, it is not uncommon at 25 years for the trees to average from 10 to 14 inches in diameter and from 50 to 70 feet in height. An open stand in northeastern Florida is shown in figure 7, where the average tree of the 17-year-old stand was nearly 11 (10.7) inches in diameter and 61 feet tall. Fire protection had been afforded throughout the life of the stand, which undoubtedly accounts for the large size and thriftiness of the trees and the maximum timber yield of the stand. Such open-grown or orchard-like stands favor the early production of merchantable sawlogs and turpentine, but sacrifice a much larger production per acre at a later date. However, moderately open-grown stands should often be favored over too dense stands. An average of the number of trees, shown in Table 1, as well as the medium diameters in the fifth column, may be taken as an approximate guide to fairly good forest conditions.

On very wet or highly acid soils, on which slash-pine seed freely germinates, the tree often makes rather slow growth and reaches only a medium size at maturity. In such situations the trees have characteristic flattened tops.

EFFECT OF TURPENTINING UPON GROWTH.

Owners who are handling their timber carefully, with the purpose of getting the most out of it, both of gum and lumber, are watching

[1] Preliminary table, based upon insufficient measurement and not to be considered as a final table.

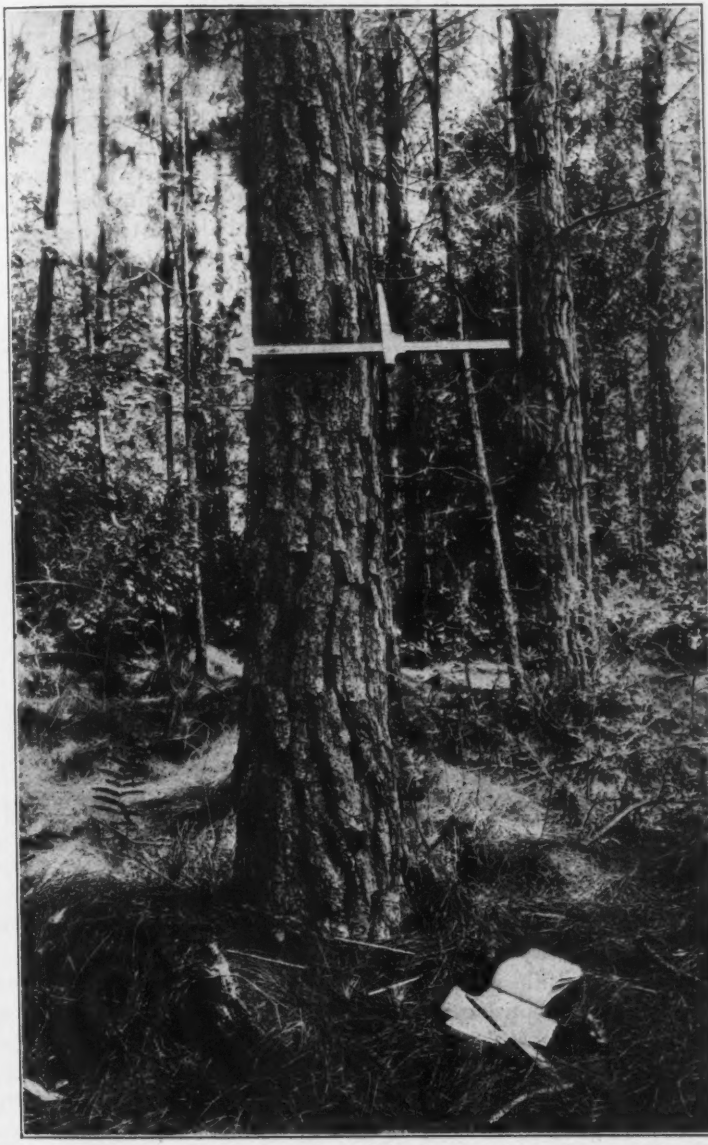

FIG. 7.—Maximum growth of slash pine resulting from continuous fire protection. The trees in this 17-year old unburned stand measured mostly from 8 to 13 inches in diameter and 50 to 65 feet tall. The average tree was 10.7 inches in diameter (breasthigh) by 61 feet tall. In the 17 years this open-grown stand had produced 12,600 board feet of lumber. The thick mat of pine leaves or straw, plainly seen in the picture, affords favorable soil protection against extremes of heat and moisture.

with interest the effect of turpentining upon the subsequent growth of the tree, particularly young timber. This is a question wholly outside of the injury and losses of timber through bad methods of working, fires, wind, and insects following turpentine operations. Although the effect of turpentining upon growth has not been definitely determined, and additional studies will be necessary to establish this point, a decrease in growth as a result is clearly indicated.

The majority of trees show a check in the rate of their growth, even when worked with only one face. On a slash pine tree, measuring 11 inches in diameter by 53 feet high, full crowned and vigorous, a face which had been made during a working about seven years previously

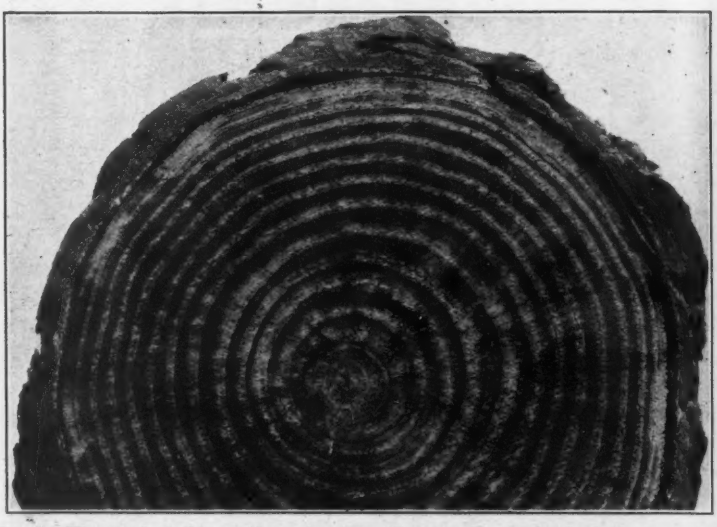

FIG. 8.—The wood of this rapid-growing tree, 17 years old, consisted of 63 per cent of dense summerwood—a very high percentage for any tree at any age. The high density of its wood from early life is a characteristic of slash pine.

was rapidly healing over. In the time elapsed, however, the tree had grown only 2 feet 9 inches in height and less than 1 inch in diameter, or about one-half the normal rate for near-by trees which had not been worked. This result does not always follow, however, and growth on worked trees frequently takes place in the same manner as on neighboring trees not worked, the face healing over rapidly. The cutting of two faces on second-growth timber often causes heavy check upon growth, besides mechanically weakening the tree to a serious extent. Trees below 12 to 14 inches in diameter grow so slowly following double facing that it would probably be better to work them completely, so as to kill them, and let the space be taken by new growth.

It appears certain that exposure to fires and the injurious agencies of rot and insect infestation subsequent to turpentining have much to do with any decline in growth that may occur along with that from the wounding and attendant loss of resin. In case this assumption be correct, it follows that slash pine, if rightly handled, may be turpentined to advantage in advance of the final working and harvesting of lumber.

TIMBER PRODUCTION.

Slash pine produces the heaviest, hardest, strongest wood of all the commercial conifers in the United States.[5] The weight of the air-

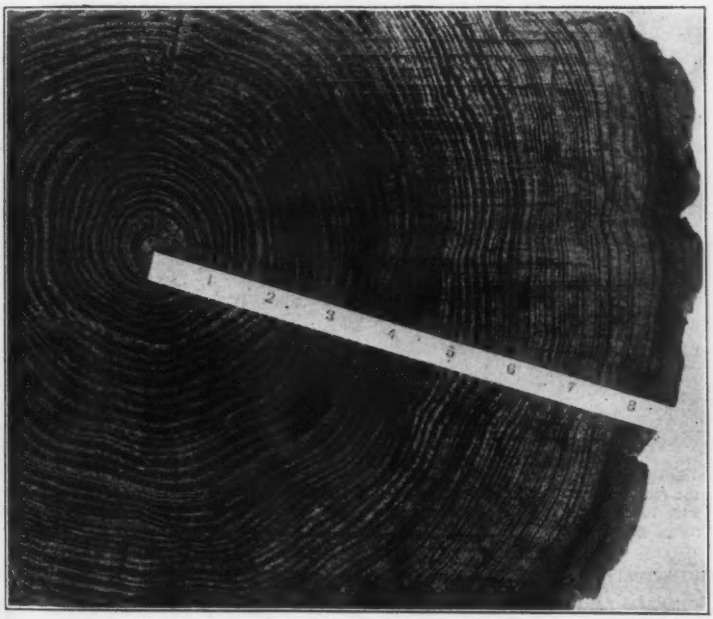

FIG. 9.—Wood from a forest-grown slash pine about 90 years old, selected as average of many specimens and representative of the timber cut from mature trees.

dry wood averages 45 pounds per cubic foot, and is exceeded among the more important commercial timbers only by the hickories and heavier white oaks. It is heavier than hard maple and beech, and about equal to white ash, yellow birch, and bur oak. In the butt cut the wood averages about 55 per cent of dense bands or summerwood,

[5] According to results of tests made at the Forest Products Laboratory, U. S. Forest Service, in cooperation with University of Wisconsin, Madison, Wis., the wood of slash pine averages a little heavier, harder, and stronger than that of longleaf.

while farther up the tree the proportion of summerwood decreases, at the top of the second cut to about 40 per cent. (Figs. 8, 9, and 10.)

Lumber of slash and longleaf pines is manufactured and marketed without distinction, and the high density of slash pine makes the wood grade high under the standard density rule.[6]

The uses of slash-pine lumber are well known. It is widely used for structural purposes and is in demand for bridges, trestles, docks, warehouses, and factories, in which it is employed for dimension timbers, posts, piles, and joists. On account of its strength and stiffness, large amounts are used for railroad cars, and its hardness and wearing qualities make it one of the leading woods for flooring

FIG. 10.—Logging mature slash pine in the flat woods of northern Florida. Because of the similarity of the woods, slash pine is cut and marketed without distinction along with longleaf pine. Note the large amount of damage to standing timber by repeated forest fires.

and street-paving blocks. The wood is also extensively used for implements and machinery, frames, and sashes, as veneers for boxes and other packages, and as boards for slack cooperage.

Young or "sap trees" of slash pine are extensively cut for railroad ties, on account of the density and hardness of the wood and its ability to take preservative treatment, and because slash pine occurs in dense stands of tall trees. Young trees about the best size for turpentine working are eagerly sought for cutting into railroad ties.

The wood of slash pine is well adapted for paper pulp, and the pulp mills located in Georgia, Alabama, Mississippi, and Louisiana take it readily along with that of other pines (fig. 11). The

[6] For information regarding the grading of southern pine, application should be made to the secretary, Southern Pine Association, New Orleans, La.

resinous matter in the wood does not interfere with its manufacture into "kraft" paper, a good grade of brown or wrapping paper of various thicknesses and shades of color. Slash pine, though not sold as such, finds a ready sale for fuel purposes on account of the highly resinous character of its wood. The clearing of old fields in the lower Gulf region, a large part of which is covered with slash pine, results in large amounts of cordwood coming on the market.

YIELD OF STANDS.

Owners of slash pine and others interested in growing it will want to know how much cordwood (fuel wood or pulpwood), crossties, and saw timber each acre is capable of producing. A knowledge

FIG. 11.—Tops and limbs of slash pine left in logging in Louisiana worked up in cordwood for paper pulpwood. This mill requires about 300 cords of pine wood daily throughout the year.

of the average yield at various ages, as well as the number of trees per acre and the average size of the trees, will help in deciding the most profitable time to cut the timber. The sizes and yields shown in Tables 2 and 3 refer to well-stocked stands, such as are commonly known as "dense" growths of trees. Actual stands may vary in yield all the way from 10 per cent to the full amount shown in the tables.

The amounts of various products referred to in the tables are based upon measurements of sample areas selected as being representative of the best, or ideal, conditions in respect to the density or number of trees per acre. Such well-stocked stands have enough trees so that

all the available air space and available soil moisture are fully utilized. Fully stocked stands do not occur continuously over large areas, but are confined generally to tracts at most containing up to a few acres in area, such as old fields, or the paths of tropical hurricanes; the figures of amounts per acre are consequently much higher than those that would result from the cutting of ordinary stands. In using such ideal tables there is always great danger of overestimating the amount of timber that is produced and may be cut from average stands as they are commonly found.

Well-stocked stands of slash pine increase their production of wood per acre rapidly up to a certain age and more slowly afterwards. At some period, considerably beyond the ages of the young second growth here under discussion, the trees begin to die out from old age, and the actual amount of wood per acre decreases.

CROSSTIES, FUEL WOOD, AND PULPWOOD.

The rate of production of cordwood for slash pine is yearly about 2 to 3 cords of wood with the bark, or 1½ to 2 cords of peeled wood (pulpwood) between the ages of 10 and 15 years; at the ages of 20 to 25 years about 1½ cords of fuel wood, or 1 cord of pulpwood; and at 35 to 40 years a little less than 1 cord yearly (Table 2). The standard cord is a stack 4 feet wide by 4 feet high by 8 feet long, containing 128 cubic feet. Such a stack of piled sticks consists of about 90 cubic feet of solid wood, varying with the straightness of the sticks and method of piling.

On most lands only scattering trees grow, or a fraction of a full stand. The trees, although individually growing much faster than in crowded stands, do not yield in the aggregate so much wood. An acre containing 100 trees, ranging from 8 to 14 inches in diameter and 50 to 70 feet high, such as might be found frequently on average cut-over lands, would cut about 25 cords of fuel wood or 20 cords of peeled pulpwood, or about 30 to 40 per cent of the yeild of a fully stocked stand.

The approximate number of crossties of standard size, 6 by 8 inches by 8 feet, that can be cut in well-stocked slash-pine stands at various ages, is shown in Table 2. With a good market prevailing generally over the South for railroad ties, small-sized timber can often be worked up advantageously into crossties. This is particularly true of the small stunted trees that should be thinned out of timber which it is desired to grow for saw-timber sizes.

TABLE 2.—*Yield of well-stocked slash-pine stands per acre in the form of crossties, pulpwood, and fuel wood.*[1]

Age.	Crossties, No. 3 (6 by 8 inches by 8 feet).	Cordwood.		Age.	Crossties, No. 3 (6 by 8 inches by 8 feet).	Cordwood.	
		Peeled wood (pulp wood, etc.).	Wood with bark (fuel wood, etc.).			Peeled wood (pulp wood, etc.).	Wood with bark (fuel wood, etc.).
Years.	*Number.*	*Cords.*	*Cords.*	*Years.*	*Number.*	*Cords.*	*Cords.*
10	.....	1 to 8	2 to 12	30	80 to 310	25 to 50	32 to 62
15	.....	9 to 20	12 to 27	35	130 to 340	28 to 54	35 to 66
20	Up to 190	15 to 35	20 to 46	40	170 to 365	31 to 58	40 to 70
25	Up to 270	20 to 45	27 to 56				

[1] This is a preliminary table, based on insufficient measurements to make the figures final. The range of figures shows the different yields on different qualities of land.

YIELD OF SAW TIMBER.

The market is taking lumber cut from smaller and smaller sized timber. This is particularly true in the South. Increasing amounts of slash pine for both local use and shipment are being sawed each year from small turpentined trees from 25 to 40 years of age.

Table 3 summarizes the approximate amounts of saw timber per acre, in terms of board feet, that can be cut from slash-pine stands of different ages, growing in well-stocked stands of approximately even-aged trees. For example, a slash-pine stand about 30 years old, of good density, taking all trees measuring 10 inches and over in diameter at breastheight, when closely sawed may be expected to yield from 2,300 on poorer land up to 13,600 board feet on better situations. If all trees measuring 8 inches and over in diameter are sawed up, the yield should be somewhere between 5,500 and 16,000 board feet. This represents an average yearly production, considering the 10-inch diameter limit, of about 260 board feet per acre, and 360 board feet for trees 8 inches and over. For the average sizes of the trees and number per acre for the corresponding ages, reference should be made to Table 1.

TABLE 3.—*Amount of saw timber in board feet grown in slash-pine stands that are even aged and well stocked with trees.*[1]

Age of stand.	Mill scale, or actual cut.[2]						Doyle rule.[3]		
	Trees 10 inches and over in diameter.			Trees 8 inches and over in diameter.			Trees 7 inches and over in diameter.		
	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.
Years.									
20	5,900	.....	.....	9,800	5,350	900	3,900	.....	.....
25	10,600	5,600	.....	13,600	8,500	3,400	5,860	3,505	1,150
30	13,600	8,000	2,300	16,200	10,850	5,500	7,220	4,710	2,200
35	15,800	10,200	4,700	18,100	12,700	7,300	8,300	5,700	3,100
40	17,600	12,200	6,700	19,600	14,200	8,800	9,200	6,600	4,000
45	19,000	13,700	8,400	20,800	15,400	10,000	10,050	7,385	4,720
50	20,200	15,000	9,900	21,800	16,450	11,100	10,750	8,075	5,400

[1] See attached sheet for footnote.
[2] The yield in lumber when closely and carefully sawed down to a top diameter inside bark of 3.5 inches.
[3] By the Doyle rule small logs scale from one-third to one-half less than the amount that can be cut in careful and close sawing.

The future yields of present stands, if left to grow for 5, 10, 15, or more years, can be predicted by referring to the yields for the corresponding ages in Table 3.

This table is for stands having approximately the proper number of trees fairly evenly spaced on the ground. The amount of lumber shown by mill scale is that which can be sawed out by using the trees down to small diameters and utilizing the material in the logs by careful sawing (with an ordinary circular saw) rather than by the old-time rough-and-ready, wasteful methods. The difference between the mill scale and the scale by the Doyle rule is striking. For example, an acre of 25-year-old slash pine well stocked on the ground, if carefully sawed, taking all trees measuring 10 inches and over in diameter (breast high), would yield on medium land up to 10,000 board feet. The very low scale of the Doyle rule, which unfortunately prevails in common use, is shown by the fact that measuring by that rule the logs from all trees in the same stand, 7 inches and over in diameter and on the same grade of location, would scale only up to 4,710 feet.

The following essential facts concerning a few of the stands actually measured will serve as an illustration of what yields may be expected from well-stocked slash-pine stands, such as are locally considered to be "dense" stands.

(1) A 21-year-old stand, consisting of 384 trees per acre, averaging 8 inches in diameter at breastheight and 56 feet in height, contained 45 cords of wood with the bark on, or 34 cords of peeled wood. If all trees measuring 10 inches and over in diameter were cut, the stand would saw out about 6,400 board feet; or if all trees 8 inches and over were taken, it would saw about 10,300 board feet. By the Doyle log rule, however, all trees measuring 7 inches and up in diameter would scale only 3,700 board feet.

(2) A 25-year-old stand, with 274 trees per acre, averaging 63 feet in height and 9 inches in diameter, contained 47 cords of wood with the bark, or 37 cords of peeled wood. The trees 10 inches and over in diameter would saw out, down to small top diameters, about 10,700 board feet per acre; or about 13,500 feet would be obtained if trees 8 inches and up in diameter were taken. If the logs in the trees measuring 7 inches and over in diameter were scaled by the Doyle rule, there would be only 5,800 board feet per acre.

(3) A 26-year-old stand, with 754 trees per acre, would cut 64 cords of wood with the bark, or 47 cords of peeled wood. There would be a total of only 1,300 board feet if trees measuring 10 inches and up were taken, or 8,000 feet from all trees 8 inches and over in diameter. The Doyle rule showed only 1,360 board feet.

(4) A 30-year-old stand, with 114 trees per acre, averaging 11 inches in diameter and 69 feet high, contained 31 cords with the bark, or 25 cords of peeled wood. There would be 9,672 board feet per acre of saw timber in the trees 10 inches and over in diameter, or 10,700 board feet in the trees 8 inches and over in diameter. If scaled by the Doyle rule, the stand had only 5,700 board feet.

(5) A 51-year-old stand, which consisted of 220 trees per acre, averaging 70 feet in height and 9.4 inches in diameter, contained 57 cords of wood with the bark, or 44 cords of peeled wood. The stand would cut out 10,100 board feet from all trees 10 inches and over in diameter, or 14,600 feet from trees measuring 8 inches and over. The Doyle rule gave only 5,900 feet of saw timber.

TURPENTINE AND ROSIN PRODUCTION.

Slash pine produces large quantities of rosin, or gum, of high quality. In this respect it excels all other native pines.

The gum of slash pine, when freshly exuded, is limpid, and about the color of light-yellow honey. As compared with longleaf or "hill" pine, its nearest competitor, it yields a higher percentage of turpentine and a relatively smaller amount of rosin of a higher grade. Beginning to run a little later in the spring than longleaf, probably because of the colder situation in low ground, slash pine keeps up a heavy flow until late in the season, considerably past the time when longleaf becomes dry-faced; furthermore, it does not produce "scrape," as does longleaf. It is not uncommon to hear it said that slash pine is more apt to die from turpentining than its associate, longleaf pine. Observations make it almost certain that the basis for this statement is the almost universal custom of more heavily cupping slash pine because of its very free production of crude gum, with its high content of spirits of turpentine, and the desire to obtain the maximum amount.

It is difficult for private owners and operators to break away from the custom of cupping very small trees and overcupping large ones. In their desire for immediate returns they sacrifice heavily in income, or "kill the goose that lays the golden egg." A case is known where slash-pine trees were cupped at 8 years old and the same trees back-cupped 7 years later. Frequently all trees down to 7 inches in diameter are cupped, two cups hung on trees down to 9 or 10 inches, and three cups hung on trees 13 inches and over by the laborers who are paid on the basis of each 1,000 cups hung, or of each "crop" of 10,000 cups. Very close working is wasteful practice, except for the purpose of clearing up land or thinning heavy stands. (Fig. 12.) With the faces ranging in width from 7 to 11 inches, the bars (portions of bark and wood left between the faces) are reduced to widths from 1 to 3 inches, which are entirely too narrow to permit of the trees functioning properly.

The flow of gum appears to be generally in proportion to the size of the trees and the size of the face, up to the point where the tree is faced too severely. Practical men in the turpentine industry are heard repeatedly expressing the opinion that a large percentage of the smaller-sized trees now bled are too small to pay for the cost of

operation. The almost complete loss by wind and fire of small trees during or after severe turpentine operations is another potent economic reason for adopting conservative methods. (Fig. 13.)

IMPROVED METHODS OF TURPENTINING.

The ultimate aim in the conservative handling of slash-pine stands is to make them continuously productive and capable of supporting a permanent and self-sustaining industry. The continuous operation of turpentine forests has been practiced for many years in France and is regarded by well-informed persons as possible and practicable in this country.

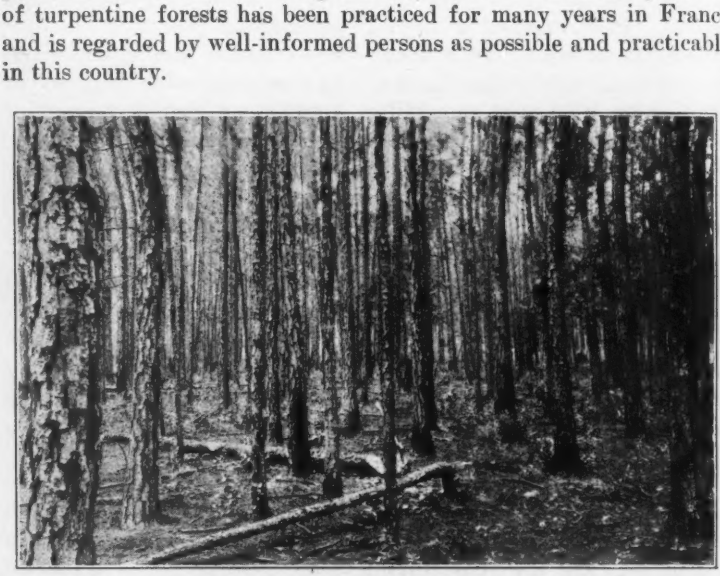

FIG. 12.—Slash pine in central Georgia ready for thinning by turpentining. The trees are 20 years old, from 5 to 10 inches in diameter and 45 to 55 feet tall. There are 474 trees of the larger sizes an acre and 922 trees an acre of all sizes.

The cupping method, instead of the wasteful boxing of trees, has become generally used by the more progressive operators, but unfortunately it is not yet prevailingly adopted. Light chipping is a step toward improved methods for securing increased yield and lessening destruction of timber. Another step in the right direction for conservative operating consists in restricting the cupping of young trees of sizes below certain minimum diameter limits, and greatly lengthening the period of operation on the individual tree and forest by proper regard for the laws of tree life, including the production of resin by the tree. A successful farmer in south Georgia, in a recent lease of turpentine rights on his timber, made the following restrictions which are probably typical of what the more conservative owners regard as the best practice with their timber:

No tree shall be bled measuring below 10 inches at 2 feet from the ground; 1 cup to be allowed on trees from 10 to 14 inches, inclusive; and 2 cups on trees 15 inches and over in diameter.

A summary of practices that are more generally recognized to be advisable as a means of getting the most revenue out of their timber, consistent with conditions of labor and market, includes the following:

(1) The cup-and-gutter system should be exclusively used. The advantages of the cup-and-gutter system over that of boxing are that (*a*) the yield of turpentine is considerably greater and the quality of the rosin better; (*b*) the loss and damage from fire is greatly lessened through the elimination of the deep cut (box) into the tree;

FIG. 13.—Early loss of small slash pine timber from deep chipping. If cupped only on one side these small trees are nearly half way cut through, making them easy prey for wind of only moderate force.

and (*c*) less injury being done to the tree, it is enabled to maintain its vigor and is less liable to be wind-thrown. One count, following a windstorm on two adjacent tracts, showed that 13 boxed trees were blown down to 4 cupped trees; also that 37 of the boxed trees died to only 17 of the cupped trees.

(2) No trees under 10 inches in diameter (breast high) should be tapped.

(3) Two faces should be allowed on trees measuring 14 inches and over in diameter at breast-height.

(4) Not more than two faces should be allowed on any tree.

(5) The faces on trees 12 to 15 inches in diameter should not exceed 12 inches in width; and those on trees above 16 inches in diameter should not exceed 14 inches in width.

(6) The height of the face should not be raised in any one year more than 16 inches, or an average of 0.5 inch in height for each 32 streaks in season.

(7) No streak should exceed a depth of 0.5 inch, the depth being measured from the dividing line between the wood and bark, the practice being known as "light chipping."

(8) The rough or outer bark of such tree to be chipped should be scraped off clean at the opening of the season before chipping begins.

(9) A space of at least 2.5 feet on all sides of each tapped tree should be raked free of litter or débris during the winter following the working.

Investigations must be carried on further to secure the information necessary for recommending any final plan of forest operation which will secure a continuous yield of turpentine. The plan briefly outlined below for second-growth slash pine will doubtless suggest ideas to owners who desire to handle their stands so that they may, in the long run, secure a continuous profit. No attempt has been made to give details, and as much latitude as is necessary is allowed for the working out of the plan.

A TURPENTINE PLAN.[7]

Turpentine operations begun when a considerable number of trees in the forest—say one-fifth to one-half—have reached 10 inches and over in diameter. Under average conditions of soil the forest will reach this stage of development at 20 to 30 years of age, varying with the tree density, or the number of trees per acre, and with the degree of fire protection. All trees 10 inches and over are then cupped with one cup per tree and carefully worked or lightly chipped for a period of 3 years to a height of not over 6 feet from the ground. The forest is then allowed to rest.

The success of the plan requires keeping up midwinter raking around the trees during periods of rest as well as of operation and the protection of the timber against heavy burnings. In about 7 years, or 10 years after the beginning of the first working, the larger trees will have reached such size that they will stand a second cupping, and many others will have reached or passed the minimum 10-inch diameter size limit. (Fig. 14.) When it appears desirable to thin out trees, for the better development of the forest as a whole, they are double-cupped and worked as heavily as possible for gum, and the remaining trees then worked with not more than one cup to the tree. At the end of this second cupping the trees previously selected for thinning are removed, together with any others that are badly injured or affected with disease or that look unpromising from

[7] Suggested by Mr. Austin Cary, of the Forest Service, U. S. Department of Agriculture.

any other cause. If the timber is thrifty, the best course after a period of rest and growth, varying in duration from 3 to 7 years, is to work the forest a third time.

At the close of this period the trees will have been completely worked over and should have reached a size serviceable for lumber. At the age of 35 to 55 years, on average locations, the trees may be expected to scale from 80 to 150 board feet of lumber, and it is practicable for them to stand 100 or more on an acre. The total yield will depend upon the number and size of trees removed after each turpentine operation. The system, when once started, will work continuously through the incoming of young growth, and may be expected, on such quality of land as is under consideration, to produce a yield in naval stores equivalent to the product from 3 to 12 faces per acre working continuously, and a yearly product per acre of 100 to 400 board feet of lumber.

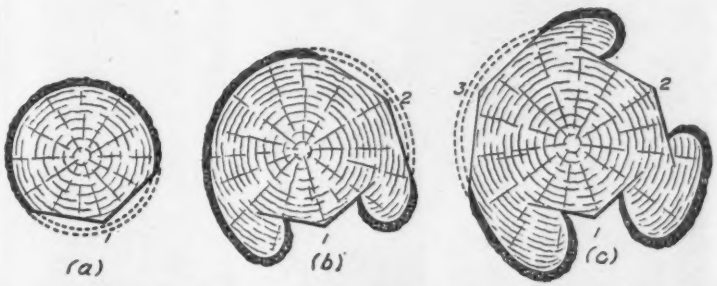

FIG. 14.—Three successive workings of a slash pine tree: (*a*) First working when 10 inches in diameter (breasthigh); (*b*) second working 6 years later, after 3-year rest period; and (*c*) third working 12 years later after high-facing the second working and allowing a 6-year rest. The tree has had sufficient live bark to keep it actively growing, although the rate of increase in size was slow while being turpentined as compared with other years.

TURPENTINING IN FRANCE.

Owners who desire to operate their young timber in the most profitable manner, after it has reached the stage profitable for turpentining, will be interested in a brief account of the methods that have been worked out during the past 70 to 100 years by the French Government in handling its forests of maritime pine (*Pinus maritima*) for turpentine and timber. Although an inferior tree for lumber, maritime pine is similar to slash pine in that it grows rapidly and yields turpentine gum freely from faces which heal over in a comparatively short time. By careful working, turpentine operations are carried on continuously in the same stand for a period of 45 to 50 years.

FIG. 15.—French turpentining on maritime pine under private ownership. The faces are concave and from 3 to 4 inches wide, depending upon the size of the tree and intensity of operation. The yield of gum per inch of face is more than that in this country. This form of face does not seriously weaken the tree, and in a few years is entirely grown over.

When a stand reaches the age of about 25 years a period of improvement thinning is begun, which lasts about 15 years. During this period, at 5-year intervals, those trees which it is desired to remove so as to stimulate crown expansion and diameter increase in the remaining trees are marked for turpentine working. When the trees are selected for early removal they are heavily cupped, under a rapid "destructive" system of turpentining for three or four years and then cut for lumber.

At the end of the above period of thinning, or at the age of about 40 years, the trees of the final stand, which number from 150 to 200 per acre, are found to be uniformly spaced, well separated, and growing vigorously. At this time is begun a period of conservative tur-

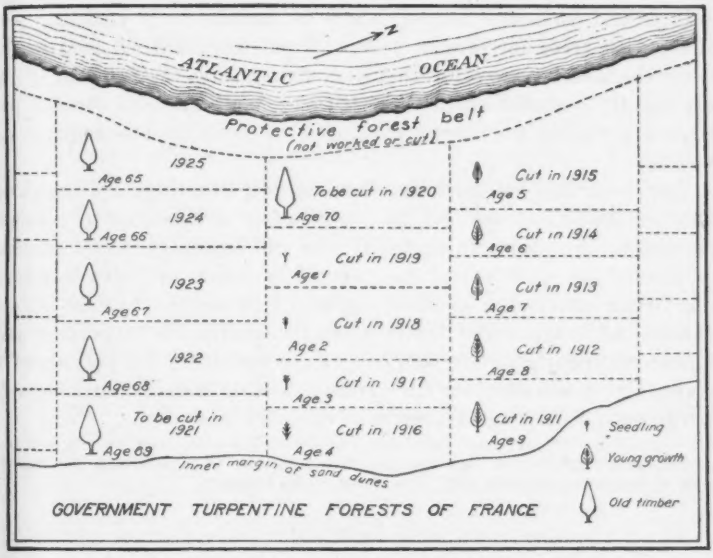

FIG. 16.—Government owned maritime pine forests of France.

pentining, lasting about 30 years, or to the end of the "rotation" of 70 years, when the stand or "block" is considered to have reached its maturity and is cut. All trees in the stand are cupped with one face to each tree and worked for five successive seasons, then allowed to rest for a period of not less than 3 nor more than 5 years. A back face is then begun and worked for 5 years, followed by a similar resting period. Then a new face is started midway between the old faces, and so on. The faces, which are from 3 to 4 inches in width, heal over rapidly. This makes it possible to start new faces or work-

ings on the same tree regularly every 8 to 10 years, depending upon the length of the resting period. (Fig. 15.) On designated trees two cups may be allowed.

Near the end of the rotation or maturity period, just prior to the final cutting, the trees in the block for 4 years are turpentined heavily by the "destructive" system in order to obtain the maximum yield of gum. At this time the stand contains from 75 to 150 trees an acre. The reduction represents losses by storms, insects, diseases, and the occasional removal of trees for which there was a special demand or which yielded more profit for wood than for producing turpentine. After the final cupping the whole stand or block is cut clean for lumber, ties, and fuel wood. No part of the tree is left on the ground except the small branches and twigs containing the foliage and cones or "burrs," which set nearly every year and persist on the trees for several years. From the plentiful seed in the cones the land is soon reforested with abundant young growth. Fires are rigidly guarded against at all times, and carefully cleared fire lines are maintained across the forest at more or less regular intervals.[8]

Each year one block of the forest is cut, thinnings are begun in another, and the block cut the year before commences to reforest naturally. As shown in figure 16, the cutting progresses westward or toward the direction of the prevailing winds in order to afford the young stands the greatest degree of protection against severe winds. Although under Government ownership the turpentine and timber-cutting rights are sold to private operators for periods of 5 years, which accounts for the arrangement of the cutting compartments, each consisting of a series of five stands or blocks.

[8] For further information regarding the French method of turpentining, see Department of Agriculture Bulletin 229, "The Naval Stores Industry."

WHAT FRANCE HAS DONE.

In France there are to-day 1,500,000 acres of private pine forest, by far the greater part of which was established on treeless sand wastes of the coastal plain, by sowing seed or by planting little trees. Much of that land is now worth from $100 to $200 an acre.

During the war, American foresters (Twentieth Engineers), in France, cut saw logs from trees in State forests located on sand dunes which, 60 years ago, were not only wholly unproductive, but a menace to the country, because they were traveling inland at the rate of 80 to 100 feet a year.

Forest planting in France has resulted in creating a naval-stores industry second only to that of the United States, in draining malarial marshes, in vastly increasing population, and in bringing lands up to a state of good agricultural production by means of utilizing the forest undergrowth and pine "straw" or leaves.

By careful methods of working, the French forests—built up from the reforestation of treeless wastes—are made to yield turpentine for periods of 30 to 50 years, after which the trees are cut for timber. The same transformation can be brought about on the cut-over pine land of the Southeastern States.

REFORESTATION.

The natural restocking of slash-pine lands with young growth may be expected to take place satisfactorily whenever sufficient seed trees are left in logging. The rapidity with which young slash pine takes possession of old fields, wet lands, vacant lands near towns and on farms, and other places protected from fire, is locally well known. The reforestation of land by means of sowing seed or planting small seedlings doubtless seems quite unnecessary and impracticable in the South, where there is already so much young growth. Such reforestation is not proceeding everywhere, however, and on account of modern methods of steam logging and the almost yearly burnings, vast areas in the South which should be growing timber are now practically idle. Many owners of small tracts and some owners of large ones are, however, seeking information regarding methods of getting young pine growth on their land.

NATURAL REPRODUCTION.

Slash pine is a somewhat heavy seed producer. Full or heavy seed crops may be counted on at intervals of two to three years, although some seed is borne almost every year. Well-developed cones ("burrs") have been observed on trees 12 years old; but, in general, trees growing in the open produce seed only after reaching the ages of 15 to 18 years. In close stands seed production, usually limited in quantity, begins at a little later age. The seed is small and provided with a wing by which it is easily carried in moderate winds as far as 100 yards, and in strong winds it often travels two or three times as far (fig. 2). As a result the seed is widely dispersed. There are about 16,000 to 18,000 seed in a pound, with 60 to 90 fertile seed in every hundred. The seed appears to retain its vitality well in storage. Seed stored for two years in covered tin containers, at ordinary office temperatures, when tested showed a germination of 70 per cent, in which one-half the seeds germinated within the first two weeks after sowing; another lot of seed similarly stored in cloth sacks for three years resulted in 28 per cent germinating. In size and general appearance the seed closely resembles that of loblolly pine, with which it is very apt to be confused. No destruction or injury to either seed or sapling by "razor-back" hogs has been reported, in striking contract to that occuring with longleaf pine.

Slash-pine seed germinates usually in the fall, within a month after it reaches the ground. If there has been a full seed crop accompanied by favorable weather during the fall and winter, as occurs at intervals of some 3 to 7 years, heavy reproduction results widely over the range of the species. A good supply of moisture is favorable to successful seed germination and the early growth of the seedlings. This, together with better fire protection, largely accounts for the abundance of slash pine in moist situations and its infrequence on markedly dry sites. The broad margins of bodies of water, grass bogs in swamps, and flatlands liable to be water-soaked for some time are favorite situations for slash-pine reproduction. Cultivation of abandoned fields disintegrates the underlying hardpan and affords moisture conditions favorable for seed beds. Young slash pine growing on such fields is commonly termed "oldfield" pine. Unfortunately, fires, which commonly occur annually or every two years, destroy vast numbers of the young pine growth of all species over the whole pine belt.

If it is desired to obtain young growth by natural means following logging, as in the continuous handling of slash-pine stands, it is necessary to provide for seed trees. The figure on the back cover of this bulletin shows a mother seed-tree left after logging and the offspring about 5 years old. Good seed-trees have short, clear trunks

and heavy tops and show vigor of growth by their full green foliage. These trees cut low-grade lumber and may be left without sacrifice of valuable timber. If grass, pine "straw," or other leaves have formed an exceptionally thick cover over the mineral soil or muck, it might be advisable to "light burn" the land during the winter or early spring preceding a full crop of seed, whether or not the timber be cut. Such action is, however, required far less often with slash pine than with longleaf, which produces a seed of large size.

SOWING AND PLANTING.

The absence of seed-bearing trees sometimes makes it necessary to start young forest growth by means of so-called "artificial" reforestation. This is merely getting a stand of trees started either by sowing the seed or by transplanting seedlings previously dug up or grown in nursery beds. Slash pine is well adapted to reproduction by either method and can be easily and successfully handled. It has a small taproot and stands transplanting well if ordinary care is taken. Slash pine, like southern cypress, shows a tendency to migrate northward, and, like many forest trees, is without doubt capable of being extended to a considerable distance beyond the limits of its present natural range.[a]

BROADCAST SOWING.

Broadcast sowings of slash-pine seed on grassy lands, followed by dragging with a spring, spike-tooth, or brush harrow, depending upon the character of ground cover, have given excellent results. A fairly heavy grass cover acts as a protection, and under such conditions better results have followed than where similar land has been freshly burned over. Plowed land broadcasted with seed and harrowed has produced practically complete stands, but the method is expensive. A sowing at the rate of 1 to 3 pounds of seed per acre seems to be sufficient to produce satisfactory stands of trees under ordinary conditions. Low, grassy lands require less seed than ridge or thinly grassed lands. Sowing seed on grass without further treatment is simple and relatively cheap and has thus far given satisfactory results. Fall sowing has resulted in a higher seed germination than sowing in the spring. It is recommended that the collection of seed in late summer or early fall be followed soon by sowing operations, preferably not later than the middle of October. For spring sowing February or March would probably be the most favorable time.

In the fall of 1917 and spring of 1918 slash-pine seed was sowed by the Forest Service in cooperation with Clemson College at the Clem-

[a] The Forest Service, U. S. Department of Agriculture, furnishes lists of dealers quoting prices on seeds and seedlings of forest trees, including slash pine.

son Coast Experiment Station, near Summerville, S. C. The land is fairly low, flat, and poorly drained, about 20 miles inland from the coast. Locally it is known as "crawfish" land and represents large areas of the Atlantic and Gulf Coastal Plain. Broadcast and seed-spot methods of sowing were used under different conditions of grass cover with varying results up to about 87,000 seedlings per acre. This last result came from early November sowing on heavily grassed-over land, followed by harrowing; a similar sowing in the grass, but without harrowing, gave a stand of over 32,000 seedings an acre. Similar broadcast sowing on a ridge with sparse grass cover and without harrowing after seeding resulted in 544 seedlings an acre, and, with the ground harrowed after seeding, in over 3,400 seedlings. In all operations seed was sown at the rate of 5 pounds an acre.

An identical series of sowings on grass-covered lands, made in March and early April following, gave a considerably less but still satisfactory number of established trees an acre.

Experiments have shown that an initial stand of about 5,000 first-year seedlings an acre should be a sufficient number for average conditions. On this basis about 1 to 3 pounds of seed sowed on low, moist, grassy lands, without further treatment, such as harrowing, should ordinarily result in a stand of satisfactory tree density.

SEED-SPOT SOWING.

Another method is to sow a dozen or more seeds in a "hill," or seed spot, dug up about a foot square and prepared for the purpose with a hoe or mattock. The seed are then covered, by hand or with an implement, with about one-quarter of an inch of soil, lightly tamped to prevent rapid drying. The seed spots are usually spaced at more or less regular intervals, depending upon the desired spacing of the young stand. A spacing of 8 by 8 feet requires 680 seed spots per acre and is generally considered a good average spacing. No better results have been obtained by this method than by the less expensive one of broadcasting and harrowing.

GROWING AND PLANTING SEEDLINGS.

Seedlings of slash pine for transplanting may be obtained by digging them up in the woods or growing them from seed in small beds in the garden. Experience indicates that slash pine possesses inherent vigor and favorable root form, which make it one of the most adaptable species for transplanting.

A seed bed 4 by 12 feet in area should be ample to produce at least 3,500 well-developed seedlings one year old (about 75 seedlings per square foot) suitable for setting out in the field or on cut-over lands.

One pound of seed (16,000 to 18,000) at this rate would be sufficient for two seed beds of this size. In case the little trees are to be transplanted when one year old to grow another year in the nursery, a pound of seed might be sowed in each seed bed and should produce not less than 6,000 seedlings at the end of the year. Such plant stock, once transplanted, is commonly hardier and is recommended over 1-year-old seedlings for particularly unfavorable locations. Ordinarily 1-year-old seedlings should prove satisfactory.

The essential points to bear in mind in raising pine seedlings in nursery seed beds are:

(*a*) Sow the seed broadcast, providing about 48 square feet of bed (4 by 12 feet) for each one-half pound of seed. This should produce 3,500 seedlings suitable for transplanting when one year old.

(*b*) Cover the seeds by sprinkling or sifting over them about one-quarter inch of fine soil.

(*c*) Keep the seed bed from becoming dry by applying a light mulch cover of fine leaves, pine straw, or grass (without seeds), and when necessary giving the bed a good wetting during dry weather.

(*d*) Afford protection against birds, mice, and other animals by screening the seed bed with woven wire.

(*e*) Keep out weeds.

(*f*) Under favorable conditions of warm weather, good soil moisture, and good seed, a germination of at least 60 per cent of slash-pine seed may be expected within the first 10 to 20 days, and the remaining germination, up to 70 per cent, soon thereafter.

Unusual care is necessary at all times to move pine and other coniferous seedlings successfully. The roots of conifers, unlike those of the hardwoods, including ordinary fruit trees, must at no time be allowed to become even partially dry. If the taproots of pine seedlings are long they should never be doubled back in the planting operation, but should be pruned to 8 to 10 inches in length and set in a vertical position. A hole of ample size should be dug; then, holding the seedling in the center at a height slightly lower than its former position in the ground, draw in the soil carefully so as to allow the roots to spread and, as fully as possible, assume their natural position. The soil should be lightly tamped with care about the roots, and it is well to add a little loose soil or leaf litter as a mulch over the surface in order to avoid injury by drying out of the soil.

A spacing of 8 by 8 feet each way (about 680 seedlings per acre) will permit of some loss of trees without too great a reduction in the resulting stand. If the situation and time of planting are unfavorable, it would be better to plant trees 6 feet apart each way, or 1,210 per acre. Slash-pine seedlings that have grown for one year in the seed bed are probably most satisfactory for field planting. Ordi-

narily 2-year-old seedlings are unnecessarily large and involve an additional cost in planting.

In the spring of 1916, 1 and 2 year old slash-pine seedlings were dug up in northern Florida and shipped by parcel post to Summerville, S. C., where they were set out. Although very late in the spring (June 2) and at the most unfavorable time for such operations, a large percentage of the seedlings lived. The Georgia College of Agriculture at Athens has had pronounced success both in growing slash-pine seedlings in seed beds and in transplanting the seedlings in the different soils of the region.

The time for planting pines in the South is preferably in the fall after active growth ceases and from then on to the spring before the buds begin to swell. After being carefully planted, pine seedlings do not require further care, except protection from fire, which is of the utmost importance. In the early fall fire lines or guards should be burned around the plantation, if there are no other means of protection, such as public roads, bodies of water, or fields. These should be wide enough to prevent fire from jumping, say from 30 to 60 yards, and may be burned out between parallel furrow strips plowed at the desired distance apart.

COLLECTING SEED.

The method used by one who has successfully collected slash-pine seed in northeastern Florida may be helpful. As soon as the cones begin to turn brown, collecting is begun, usually about September 10 to 15. The cones are picked from trees felled in logging operations and taken in burlap sacks to the man's home. They are then placed in trays made of 1 by 6 inch lumber, about 3 feet square, with bottoms screened with ordinary wire fly-screen. The trays are set on blocks to keep them off the ground, exposed fully to the sun, and covered during the night and wet weather. As the cones open up the seed are shaken out and later rubbed with a stiff brush against the screen to free the seed from the wing. They are next sifted in a coarse mesh to separate the trash and afterward are winnowed. This gives a fairly clean seed. Another method of drying and opening the cones would be to spread them out on a tight floor in a well-aired, dry building, beating or turning them to shake out the seed.

FARM FORESTRY PROFITABLE IN NEW ENGLAND AND FRANCE.

In New England, farmers are raising timber and deriving good income from their woodlands. Individual cases are numerous of owners selling 30 to 50 year old second-growth white pine on the stump at $200 to $400 an acre. This represents yearly gross returns mostly of $6 to $12 an acre.

In France, pine has been planted extensively and grown profitably on lands no more favorable than those in the South. Some 35,000 acres of sand dunes along the coast and adjacent practically worthless lands have been converted into the source of a steady and profitable turpentine business. Much of the land is now worth from $100 to $200 an acre.

FIRE PROTECTION.

If southern pine lands have seed trees and are protected, young growth will generally spring up in sufficient abundance for a new crop. Young pine that is afforded protection from fire grows rapidly and creates wealth. Protection of the cut-over lands from fires would mean in a relatively short time the turning of millions of acres of idle lands into profitable growing crops of turpentine and timber. To a considerable extent this would be true if fires had been less frequent or handled under control.

Fire protection, while very desirable throughout the life of slash pine, is particularly so during the first three to five years of the life of young seedlings. The rapid growth soon takes the sapling above the hottest fire zone, which occurs just above the dense grass. In this respect slash closely resembles loblolly pine, but differs widely from longleaf pine, which has a protective covering of bark, dry scales, and green leaves, fitting it to withstand fires to a remarkable degree. Although trees that have attained heights of 3 to 6 feet are injured and sometimes destroyed by slow or "cool" fires, yet a sufficient number of trees generally remain for the growth of a fair stand. Stands of pine which have not passed through repeated fires are very rare in the South.

Fire is responsible for the greater part of all damage and loss of both young growth and mature timber. Fire damages and weakens trees, making them easy prey for insects and wood-rotting fungous diseases or so-called "punks." Trees weakened by fire are easily windthrown, and this causes the loss of large amounts of pine timber (fig. 17). Millions of young pine trees, the foundation of the future forest income, are killed yearly by fire. Other millions of young saplings are defoliated and otherwise injured, resulting in stunted growth. The period of growth in which to reach merchantable sizes is thus lengthened and the financial returns decreased.

PROFITS FROM SLASH PINE STANDS.

The financial returns from second-growth pine, on the farm or small holding, are not difficult to determine if fire, the chief source of damage and loss, is absent or relatively easy of control. Under fire

prevention or control the lands are naturally restocked without expense and the timber growth is rapid. A very favorable situation

FIG. 17.—The result of repeated fires. Although "standing on only one leg" this slash pine is still living, but will likely be thrown in the next strong wind.

on many farms or plantations is that second-growth pine from 20 to 40 feet in height already occurs, frequently covering a considerable

part of the farm. If the timber is slash pine it will be merchantable for turpentine, ties, pulp wood, and firewood at ages of 20 to 30 years, yielding from 12 to 60 cords of wood per acre. Older stands, from 30 to 40 years of age, yield saw timber at the rate of 7,000 to 18,000 board feet per acre. Thus slash pine affords a choice of two sources of revenue. The value of young growth is being realized more and more as utilization includes smaller and smaller sizes of timber. Under these conditions, obviously, only a comparatively few years are required for rapid-growing kinds of trees to become merchantable.

Crude turpentine, or gum, usually sold in the standing tree, has long been looked upon in the South as a standard farm product

FIG. 18.—Slash pine boxed and worked for four years and now being worked for the second time by the better method of cupping. (South Carolina.)

(fig. 18). In Bryan County, Ga., farmers are cupping their timber and selling the gum to the local stills. After trees reach about 8 to 10 inches in diameter, cupping them for turpentine is extensively practiced. For closely grown slash-pine stands this size corresponds to ages between 20 to 30 years on good soils and 35 to 50 years on unfavorable situations. Open-grown trees reach this size at ages of 15 to 25 years. Many farmers and other small timber owners have derived a good profit from selling the turpentine rights to operators of stills for 10 cents a face or cup, for a period of three years' working. This price used to be a prevailing standard, but in 1919 it reached from 15 cents a cup on average private timber to a little over 25 cents on timber in the Florida National Forest. When carefully turpentined for a period of 6 to 15 years or more, including resting intervals, and then turned into rough wood products or lumber, slash pine can be handled on short rotation or at an early age with good profit.

The recent demand for timber to be used in making ties, poles, excelsior blocks, and stavewood indicates good markets hereafter for small-sized timber. New paper-pulp mills, which require large amounts of pine of small sizes, are being established in the South in regions not covered by similar mills. The pulp wood in some instances is drawn from locations 300 miles from the mill. Lumber of smaller and poorer grades is being used each year in increasing amounts. (Fig. 19.)

EXAMPLES OF PROFIT.

Throughout the South Atlantic and Gulf Coastal Plain frequent examples are met with of profitable returns from stands of second-

FIG. 19.—Cotton, sugar cane, and slash pine—a common sight in the South.

growth slash pine. In addition to that given on page 7, a few examples are given here for further illustration.

THIRTEEN-YEAR-OLD STAND.

The slash-pine stand shown in figure 20 was turpentined at the age of 13 years. The operation furnishes a concrete example of the commercial value of slash pine when worked at an early age, although it unquestionably would have been a better investment if the owner had waited from 7 to 12 years longer.

The stand had come up naturally on an old field in the flat, sandy pine barrens 15 miles northeast of Lake City, Fla., and conditions for growth were more favorable than on adjacent uncleared lands. It contained 628 trees per acre, of which 500 were dominant, thrifty trees of value and promise. Some of the dominant trees reached a

diameter of 10 inches, but most of them ranged from 5 to 8 inches, with a height of 40 to 50 feet. On an average, 104 trees an acre were boxed, which is an out-of-date and wasteful method of turpentining.

For the turpentine rights for a 3-year lease the owner in 1916 received 10 cents a tree or box, or a total of $10.40 an acre. At the present price of 20 cents a box, the privilege would have brought the owner $20.80 an acre.

The trees when tapped contained 500 fence posts suitable for preservative treatment, and at the end of the three years' lease, allowing for reduced rate of growth, should have contained not less than 640

FIG. 20.—Thirteen-year-old slash pine stand being worked for turpentine. Unfortunately the injurious "boxing" instead of cupping method was used. There are 628 trees an acre, of which 104 trees an acre are being turpentined, bringing the owner $10.40 an acre and leaving 524 trees an acre for later workings. This is a profitable way of thinning and making young timber profitable. It should be understood that this stand represents probably the maximum average growth and yield.

posts worth at least 1½ cents each in the tree, or $9.60 an acre. The value of these posts and the gum, at the 1920 rates, gives a total gross return of $30.40 for a period of 16 years (13 plus 3 years), or an average of $1.90 a year. With no cost for establishing the forest stand or caring for it afterward and with very low taxes on the poor, sandy flatland, the annual net revenue, figured as low as $1.50 to allow for compound interest on the land and taxes, represents an annual return of 15 per cent on land worth $10 an acre—a very high figure for this kind of land.

After the boxed trees are removed, a stand of 396 trees an acre will remain. By this opening up of the formerly overcrowded stand

the trees will be stimulated to faster growth than is shown in Table 2, and, in the course of 4 to 9 years after first working, good turpentine trees, 20 to 25 years old, will be developed as large in diameter as those first worked, or larger. Calculation, based on the average past rate of growth, shows that at the age of 22 years, or six years after the end of the first working, there will be ready for the second working about 172 trees measuring 7 to 9 inches in diameter, and 152 trees 10 inches and over, a total (after deducting 10 per cent to cover possible losses) of 292 trees an acre. Working these trees with one face per tree to high faces and assuming a price of 30 cents for each cup, the stand will bring in a second revenue of $87.60 an acre, or a yearly average for the period of 12 years[9] of $7.30 an acre. The boxed timber will still be on hand, and, when sold, would add an appreciable amount to the yearly return.

TWENTY-YEAR-OLD STAND.

Reproduction of slash pine on a tract of low flatland of muck and sand soil near the town of Starke, Fla., is typical of conditions resulting from fire protection near many southern towns. The trees on this tract are mostly 21 years old, and it is reported that the ground has not been burned over in several years. The tract contains a total of 384 trees an acre of all sizes, of which 252 trees measured as much as 7 inches in diameter and over, and 55 to 65 feet in height. There are 192 trees an acre measuring 7 to 10 inches inclusive, 56 an acre with diameters of 11 to 14 inches inclusive, and 4 trees an acre 15 inches and over in diameter. If turpentined according to prevailing methods,[10] they would yield 316 cups per acre.

The present cordwood yield is about a maximum. The stand measured 45 cords an acre, or an average for the 21 years of about 2 cords an acre yearly. This is the equivalent of an annual yield of 300 to 600 board feet of lumber, depending on the utilization. The satisfactory growth is doubtless due to the absence of fire from the stand, for other fully stocked stands on similar situations and without fire protection at the same age, as a rule, show somewhat less production. An unburned stand as old as 20 years is rare in the South.

The value of the stand in 1920 may be taken at $63.20 for turpentine at 20 cents a cup, and $22 for cordwood, making a total of $85.20 an acre. This is an average yearly return of $3 for turpentine and $1 for wood, or a total gross yearly return on the land of $4 an acre,

[9] Six years after the close of the first working plus six years of working, at the rate of 20 cents for the first face and 10 cents for the high face.

[10] One cup each for trees 7 to 10 inches inclusive, 2 cups on trees 11 to 14 inches, and 3 cups on trees 15 inches and over. This, of course, represents destructive practice.

of which ordinarily four-fifths, or $3.20 an acre, may be considered as clear profit.

TWENTY-FOUR-YEAR-OLD STAND.

An overcrowded stand of slash pine 24 years old, containing 366 trees of all sizes an acre, is now being turpentined for the third year. The trees are mostly from 50 to 60 feet tall and slow-tapering. The dominant trees range in diameter at breastheight mostly from 7 to 10 inches, with about 20 trees an acre of a size from 11 to 12 inches in diameter. This stand came up on land formerly covered by a shallow pond in Bradford County, northern Florida, and the forest growth has been repeatedly run over by light fires.

About 256 cups an acre are found on trees measuring 7 inches and over in diameter. Two cups are hung on trees 11 inches and over, and sometimes on 10-inch trees. A number of the 7 and 8 inch trees, after three years of working, have become so weakened along the gutter line by deep chipping that they have broken off. This condition, in case of a heavy fire, would result in the destruction of the faces and the killing or consuming of many trees.

The money return on this natural second-growth forest at 10 cents a cup, the price received by the owner, averaged $25.60 an acre for turpentine. At a rate of 20 to 25 cents a cup, the revenue would amount to from $51 to $64 an acre for crude gum. This stand contains 126 trees an acre, 8 inches and over in diameter, large enough for common lumber. If carefully sawed, these trees would yield about 5,000 board feet of lumber, or, if cut into ties, would yield about 90 standard No. 3 size an acre. The stand now contains 30 cords of firewood or 22 cords of pulpwood (bark removed). At 50 cents a cord for firewood the timber is worth $15 an acre standing. A fair stumpage price, or value in the tree, would be 10 cents each for ties or $1 a cord for pulpwood. This would make the standing trees, after turpentining, worth to the owner from $9 for tie timber to $22 for pulpwood. The two sources of revenue—from gum (at 10 cents a cup) and ties—give the owner a gross return of $34.60 an acre at the old price for turpentine. At a price of 20 cents a cup the two revenues would amount to over $60 an acre. This is an approximate yearly average for 24 years of $2.50 per acre. With taxes on this land so low as to be almost negligible, and with no cost of growing the crop, the net return may safely be placed at not less than $2 an acre yearly.

TWENTY-SIX-YEAR-OLD STAND.

A stand of 26-year-old slash pine consisted of a total of 754 trees an acre, of which 366 measured 7 inches and over in diameter, the

customary turpentine size. Only a small number of the larger trees, from 60 to 65 feet in height, measured 10 inches in diameter on account of the crowded condition of the stand (fig. 21). This stand now contains 64 cords of wood an acre, and, if it were turpentined according to the prevailing very close method of one face on trees 7 to 10 inches in diameter and of two faces on larger trees, would yield annually 366 cups an acre. If cut clean at the end of the third year of working, it would yield 67 cords of wood. These products, at the current price (1920) of 20 cents a cup and 50 cents a cord, give a stumpage value an acre of $73.20 for turpentine and $33.50 for cord wood. This total of $106.70 for a period of 29 years[11] represents an average gross income of $3.68 yearly.

FIG. 21.—Crowded 26-year-old stand of slash pine with 366 trees an acre measuring from 7 inches to 10 inches in diameter. Maximum production of wood—64 cords of slash pine an acre or an average growth of about 2½ cords an acre yearly. This is equivalent to over 1,000 board feet. If turpentined now with only one face per tree, at 20 cents a cup the stand would yield $73.20 an acre, and there may be expected 70 cords of wood an acre at the end of the 3-year period.

RELATED PUBLICATIONS OF THE DEPARTMENT OF AGRICULTURE.

Some of these related publications, marked with an asterisk (*), are no longer available for free distribution, but the prices at which they may be purchased are indicated. Application for free publications should be made to the Division of Publications, Department of Agriculture, Washington, D. C., and for all others to the Superintendent of Documents, Washington, D. C. Inclosures of the amount of the purchase should be made in coin or money order.

*Mechanical Properties of Wood Grown in the United States. 1917. (Department Bulletin 556.) Price 10 cents.

[11] Present age of 26 years with 3 years added for turpentining.

*Relation of Light Chipping to the Commercial Yield of Naval Stores. 1911. (Forest Service Bulletin 90.) Price 10 cents.

*Turpentine: Its Sources, Properties, Uses, Transportation, and Marketing. 1920. (Department Bulletin 898.) Price 15 cents.

Oleoresin Production: A Microscopic Study of the Effects Produced on the Woody Tissues of Southern Pines by Different Methods of Turpentining. 1922. (Department Bulletin 1064.)

Tests of the Absorption and Penetration of Coal Tar and Creosote in Longleaf Pine. 1918. (Department Bulletin 607.)

The Southern Pine Beetle. 1921. (Farmers' Bulletin 1188.)

How Lumber is Graded. 1920. (Department Circular 64.)

Waste in Logging Southern Yellow Pine. 1905. (Yearbook Separate 398.)

Making Woodlands Profitable in the Southern States. 1920. (Farmers' Bulletin 1071.)

Production of Lumber, Lath, and Shingles in 1918. 1920. (Department Bulletin 845.)

*Timber Depletion, Lumber Prices, Lumber Exports, and Concentration of Timber Ownership. 1920. (Report on Senate Resolution 311.) Price 25 cents.

The Cut-over Pine Lands of the South for Beef-cattle Production. 1921. (Department Bulletin 827.)

*Small Sawmills. 1918. (Department Bulletin 718.) Price 10 cents.

Longleaf Pine. 1922. (Department Bulletin 1061.)

Application should be made to the various State foresters for needed information, since their publications usually apply to local conditions and are therefore very useful.

SUMMARY.

Because slash pine grows rapidly and the lumber market is fast taking lumber of smaller sizes and poorer grades, the day is rapidly approaching when good stumpage prices can be obtained for young and second-growth timber.

Slash pine grows rapidly in dense stands and, at 15 to 25 years of age, yields large amounts of crude turpentine. Concrete examples of well-stocked stands of young growth, after making liberal deductions for taxes and fire-protection costs during the period, show profits of 8 to 12 per cent compound interest on an investment of $5 an acre.

Open-grown slash pine, on average situations, may be expected to produce in 40 years a merchantable log 40 feet long, measuring 10 inches at the top by 18 inches at the butt, and containing 270 board feet of lumber.

Land of average quality in slash pine may be expected to yield continuously a net revenue from crude turpentine or gum of 50 cents to $1.25 an acre and an equal amount from the timber growth, or a combined yearly net return of $1 to $2.50 an acre.

The picture on the back cover shows a slash-pine mother seed tree, left in logging in southeastern Louisiana about 17 years before, and its 15-year-old offspring.

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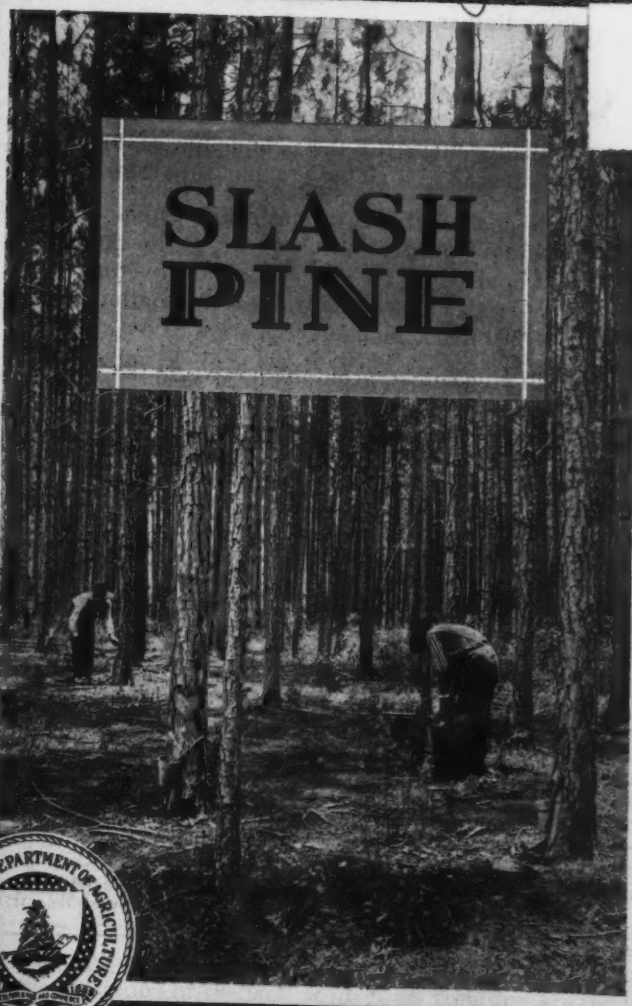
SLASH PINE



XUM

SLASH PINE grows rapidly and yields revenue in turpentine gum at an early age while it is growing timber.

Farmers and other owners of cut-over pine lands in the South Atlantic and Gulf regions are deriving a good profit from poorly drained and other lands by utilizing them for the production of turpentine and timber as well as the grazing of livestock.

Well-stocked stands of slash pine produce timber for ordinary purposes in 30 years, at the rate of 100 to 250 board feet an acre a year on average poor-quality land, and on average good situations at the rate of 300 to 500 board feet yearly.

Slash pine can be profitably grown in the South on poor and wet lands.

There are millions of acres in unimproved parts of farms and in cut-over lands that are profitless for agriculture, but suitable for the production of timber and naval stores.

By proper methods of cutting and protection, southern pine forests can be perpetually renewed and kept continuously productive.

Young pine is valuable.

The picture on the title page is second-growth slash pine in southern Georgia being worked for turpentine.

Washington, D. C.

Issued May, 1922
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SLASH PINE

By WILBUR R. MATTOON, *Extension Forester, Forest Service*

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SLASH PINE—A DUAL CROP

SLASH PINE, a native of the South Atlantic and the Gulf region, is one of the most profitable forest trees in the United States.[1] In its own range it is being extensively cared for and planted as an orchard because of its rapid growth and high value for the production of naval stores, pulpwood, and lumber.

Second-growth slash pine, following the cutting of the original forest, has spread rapidly over large areas of flatlands and low uplands of the region. It has been particularly aggressive in establishing itself on old fields and other idle or waste lands about farms and towns. Not less than 80 per cent, it is estimated, of the total amount of sap pine cut for pulpwood and crossties in southern Georgia and northern Florida is slash pine. Timber from original growth trees is used or sold without discrimination along with longleaf pine.

The heartwood of slash pine is the heaviest, hardest, and strongest of all pines of the United States. The yield of crude turpentine from slash pine is the largest from any of our native trees. In the economic development now well under way in the South, slash pine is playing a large part in bringing nonagricultural lands into their most profitable use.

A caution in managing slash pine lands can not be too strongly emphasized. The custom of turpentining small trees before they reach the age of profitable working and ample seed production calls

[1] The botanical name is *Pinus caribaea* Morelet. Formerly in forestry literature the tree was called Cuban pine.

The right use of the turpentine hack and later the ax and saw, and the protection of the land at all times from fire are the keys to the problem of growing slash pine profitably as a crop.

for special attention in management. There should in all cases be an abundance of seed just before making the final cutting of the

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FIGURE 1.—A young generation of slash trees about 14 years old is shown with their mother tree. Light orange-colored scales or plates of bark serve to distinguish mature slash pines from all other trees

timber crop so as to provide for the renewal of the stand as the necessary basis for another timber crop on the land.

How can you tell slash from other pines?

Because of the general resemblance of young slash pine to vigorous loblolly pine, and of the mature slash pine to longleaf pine, considerable difficulty is experienced by persons unfamiliar with the southern pine forest in differentiating the species. However, slash pine is not difficult to identify if one possesses the essential information regarding the leaves, cones (burs), bark, and winter bud.

The bark is fairly similar to that of longleaf pine. (Fig. 1.) It differs from that of loblolly pine by being less deeply furrowed. Old mature slash pine may be readily told by its orange-colored bark plates or scales.

The leaves grow in clusters of two or three, usually with more of the 2-leaved clusters. They are mostly 8 to 12 inches long, and bright, glossy rich green. (Fig. 2.) The heavy, shiny green foliage helps greatly in distinguishing slash pine from the associated longleaf pine with its coarser and rather bluish-green foliage. Loblolly pine, like longleaf pine, has three bluish-green leaves in a cluster, but has much smaller leaves than longleaf or slash.

The cones are egg shaped and average 3 to 4 inches in length and when closed, are about 2 inches in width. (Fig. 2.) A prickle is borne on the lustrous or varnished brown end of the cone scale.

FIGURE 2.—Cone or "bur," 2-leaf clusters, and a cone scale of slash pine. The ends of the cone scales are plump, rounded, lustrous brown, and bear a small prickle. At the base of each scale two seeds are borne, each with an ample wing for wide dispersal. Leaf bundles of slash pine contain either two leaves or three leaves in a cluster

The terminal bud is large, reddish brown in color, and in the spring elongates into a straight, stout, light-gray "candle," about the thickness of a large pencil. Longleaf pine, in distinction, has a similar but larger bud elongating into a light-gray candle, an inch or more in diameter.

The main characteristics by which slash pine may be identified are the 2-leaf or 3-leaf clusters of long, dark-green leaves; the slender prickle on the cone, pointing straight or slightly curved upward on the lustrous-brown scale of the fresh mature cone; and the early

spring candle or shoot, which is light gray, erect, and about one-half inch in diameter.[2]

Mature trees of slash pine rise to heights of 80 to 125 feet, with clear lengths of 40 to 70 feet. Diameters of trunks range from 2 to 3 feet, measured at breast height, or 4½ feet from the ground.[3] Old-growth trees at maturity are mostly from 100 to 200 years old.

WHERE SLASH PINES GROW

The natural range of slash pine extends from about Charleston, S. C., westward through the lower parts of Georgia, Alabama, Mississippi, and southeastern Louisiana to the Mississippi River. (Fig.

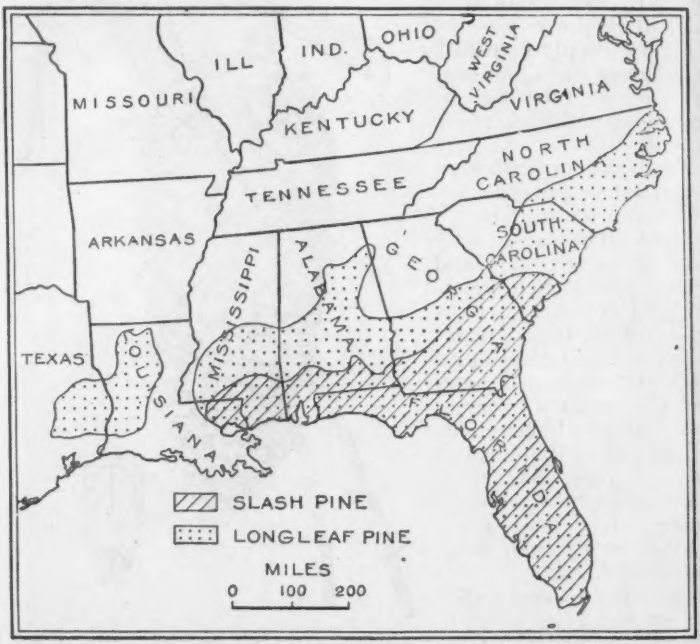

FIGURE 3.—Slash pine is found growing naturally in the region shaded by horizontal lines. Longleaf pine is found in the region indicated by scattered dots. Both kinds of pine thus occur in the slash pine belt

3.) Large areas of slash are in Georgia and in Florida, where the tree grows nearly to the end of the peninsula. Slash pine is commercially important over its whole range.

In the original forest slash pine was confined mostly to the poorly drained flat lands and borders of swamps and bodies of fresh water. With the subsequent extensive cutting slash pine became released in much the same way as loblolly pine was farther north, and it is now

[2] The spring shoot of loblolly is grayish green, slender, and often curved or drooping instead of erect.

[3] Unless otherwise stated, all diameters referred to throughout this bulletin are based on measurements at breast height.

FIGURE 4.—Thrifty slash pine trees 22 years old. The smaller trees can profitably be worked and cut out, leaving the larger trees to grow a crop of saw timber

spreading widely over lands formerly dominated by longleaf pine. (Fig. 4.) It is found on many different kinds of land, but not on dry

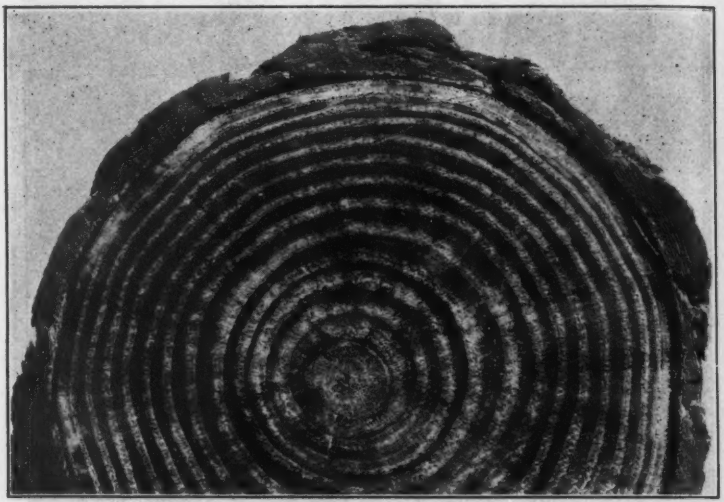

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FIGURE 5.—The very dense or heavy wood of the slash pine, formed even during its early years, is a good characteristic of the tree. The 17-year-old tree shown in the section produced wood consisting of 63 per cent of dense summer wood, leaving only 37 per cent of soft spring wood

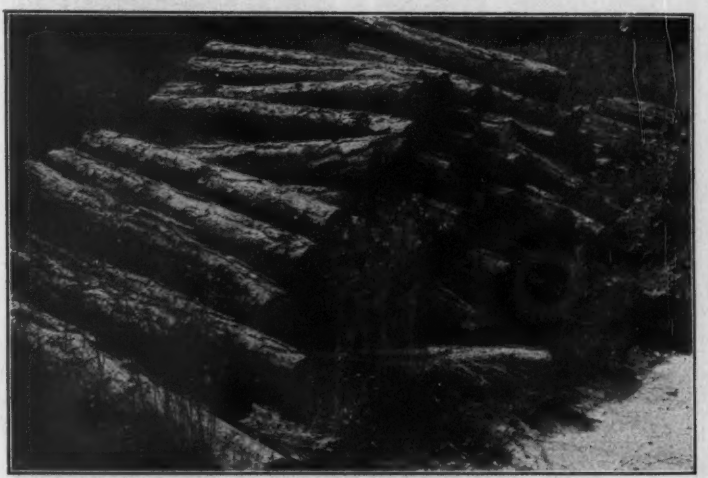

FIGURE 6.—The use of southern pine for paper pulpwood is rapidly increasing. The pulp mills buy round or split wood from 3 to 12 inches in diameter. Apparently there will be a much larger demand than at present for slash and other pines for making paper

deep, sandy ridges. On wire grass and palmetto flats it is often the only second-growth species of pine. Slash pine thrives extensively

over the low, rolling or hilly lands of southeastern Georgia, in sandy loam soils in poorly drained situations, and in the wet, mucky soils of bays, ponds, and swamps. It will tolerate a highly acid condition in the surface soil, and a calcareous substratum does not appear to be unfavorable to its growth. On soils with hardpan at shallow depths the tree appears to be somewhat dwarfed in size. It is absent from the very dry, deep sands of the "pine-barren" hills, such as are found in parts of western Florida and southern Mississippi; but even in those sections it is locally abundant on wet flats and close to lakes and streams and in the numerous ponds scattered all over the coastal plain. By means of planting the range of slash pine is being considerably extended.

THE WOOD AND ITS USES

Slash pine heartwood is the heaviest, hardest, strongest wood of all the commercial conifers in the United States.[4] The weight of

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FIGURE 7.—Slash pine trees grow in close or dense stands and are cut in great numbers for telephone and power-line poles. After being treated with creosote they can be used for 20 to 40 years

the air-dry heartwood averages 45 pounds per cubic foot. In the butt cut the wood averages about 55 per cent of dense bands of summer wood, while farther up the tree the proportion of summer wood decreases, at the top of the second cut to about 40 per cent. (Fig. 5.)

What are the chief uses of the wood?

The lumber from mature slash pine is used for structural purposes and is in demand for bridges, trestles, docks, warehouses, and fac-

[4] According to results of tests made at the Forest Products Laboratory, U. S. Forest Service, in cooperation with the University of Wisconsin, Madison, Wis., the wood of slash pine averages a little heavier, harder, and stronger than that of longleaf.

tories, in which it is employed for dimension timbers, posts, piles, and joists. On account of its strength and stiffness, it is used for railroad cars, and its hardness and wearing qualities make it suitable for flooring. It is extensively used for veneers for boxes and other packages, and as boards for slash cooperage.

Second-growth or "sap" slash pines after being turpentined are extensively cut for use as crossties and pulpwood.

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FIGURE 8.—The adaptability of slash pine to heavy wet soils enables it to grow rapidly even in dense stands, thus producing a large amount of timber in a relatively short period

The wood of slash pine is well adapted for making paper pulp, and the mills accept it (fig. 6) readily along with that of other kinds of pine. The wood is manufactured into "kraft" paper, which is the extensively used brown or wrapping paper, and it is made in various thicknesses and shades of color. The paper industry is

expanding rapidly throughout the pine region of the South. Analysis has shown a low percentage of resin in sapwood of cut trees. Slash pine is also used extensively for fuel. Because slash pine occurs in dense stands of straight clean trees, it is one of the choicest timbers for poles and piling, for which use it is cut in large quantity and brings good prices. (Fig. 7.)

GROWTH OF TREES

Slash pine is one of the most rapid growing and earliest maturing of all our forest trees. Growth in height and in diameter is especially rapid during the younger stages up to about 20 years of age. One-year-old seedlings commonly reach 8 to 12 inches in height. At 5 years, slash pines range mostly from 8 to 12 feet in height. During the next 5 to 10 years an upward growth of 2 to 3 feet yearly is not uncommon. When about 20 to 25 years of age the rate of upward growth of slash pine slackens, apparently being about the same as that of longleaf on situations of similar grade. In crowded stands (fig. 8) the increase in diameter is slower than that of trees growing a considerable distance apart. Table 1 shows for different ages the average heights and diameters of slash pine trees and the number of trees per acre found in well-stocked stands. The range in size at any given age varies chiefly with the favorableness of the soil or situation, and with the tree density, or number of trees per unit area.

TABLE 1.—*Average size of slash-pine trees at different ages grown in open and in close stands on different grades of soil; also average number of trees per acre*

Age of trees, years	Height of trees on—			Diameter of trees (breast height)						Number of trees per acre in fully stocked timber stands [1]
				Open-grown stands on—			Close-grown stands on—			
	Good land	Average land	Poor land	Good land	Average land	Poor land	Good land	Average land	Poor land	
	Feet	*Feet*	*Feet*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	
15	48	39	29	8.8	6.9	5.2	6.6	5.2	3.9	55
20	61	48	36	10.3	8.0	5.9	7.7	6.0	4.4	150
25	71	56	42	12.3	9.6	7.1	9.2	7.2	5.3	265
30	79	63	48	13.7	10.8	7.9	10.5	8.3	6.1	300
35	86	69	52	15.2	12.0	9.0	11.7	9.2	6.9	305
40	92	73	55	16.6	13.1	9.9	12.8	10.1	7.6	295
45	96	77	58	17.1	13.5	10.1	13.7	10.8	8.1	280
50	100	80	60	18.1	14.2	10.7	14.5	11.4	8.6	260
55	103	83	62	18.8	14.8	11.0	15.0	11.8	9.0	245
60	106	85	64	19.4	15.2	11.6	15.5	12.2	9.3	230

[1] All trees 7 inches and over in diameter outside bark at breast height. The trees on the better qualities of land are fewer and larger in diameter; the number on the poorer lands is greater and the trees are smaller in diameter.

How fast do slash pine trees grow?

For example, as shown in Table 1,[5] at 15 years of age the trees in well-spaced stands range in height from 29 up to 48 feet, and in open-grown stands (columns 5, 6, and 7) in diameter from about

[5] The tables of growth, volume, and yield of timber and much of the information on good turpentine practices are based upon the results of studies carried on by the southern forest experiment station of the U. S. Forest Service, located at New Orleans, La.

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FIGURE 9.—Example of fastest growth of slash pine resulting from continuous fire protection. The trees in this 17-year-old unburned stand measured mostly from 8 to 13 inches in diameter and 50 to 65 feet tall. The average tree was 10.7 inches in diameter (breast height) by 61 feet tall. In the 17 years this open-grown stand had produced 12,600 board feet of lumber. The thick mat of pine leaves or straw, plainly seen in the picture, affords favorable soil protection against extremes of heat and moisture

5 to more than 8½ inches. If, however, the trees have grown closely with less space for development, it is not uncommon to find them from about 4 to 6½ inches in diameter at breast height, as shown in columns 8, 9, and 10. At 30 years slash pine stands usually consist of trees ranging from 48 to 79 feet in height, and in diameter in open stands from 8 to 13½ inches, or in crowded stands from 6 to 10½ inches. Crowded stands 30 years old may have about 300 trees per acre that measure 7 inches and more in diameter. Open, or better-spaced stands for turpentining may have from 150 to 200 trees per acre.

The sizes of trees growing in good grade of soil are shown in the columns headed "Good land." The class "Poor land" includes very wet or highly acid soils, on which, however, slash pines often seed freely, but the trees make only slow growth and reach relatively small sizes at maturity. The "Average land" class applies to the great bulk of lands on which slash pine is found growing.

An open stand growing in an old field in northeast Florida is shown in Figure 9, where the average tree of the 17-year-old stand was nearly 11 inches in diameter and 61 feet tall. Fire protection had been afforded throughout the life of the stand, which undoubtedly accounts for the large size and thriftiness of the trees and the maximum timber yield of the stand. Such open-grown or orchard-like stands favor the early production of turpentine and merchantable saw logs, but sacrifice a larger production per acre at a later date. However, moderately open-grown stands should be favored over too dense stands.

Do tree trunks lengthen?

Yes, but only by new growth at the top. Once the side limbs are formed, or set, they remain in that same position throughout the life of the tree, or until they die and drop off. All limbs or branches from the main trunk reach to the heart or center of the tree.

THINNING PINE STANDS

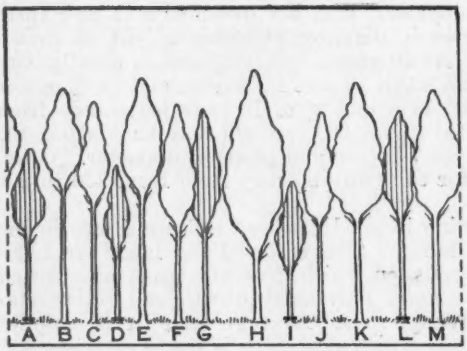
What effect does thinning have upon growth?

As in a stand of corn or cotton, the trees in a full pine stand crowd upon each other, and the stronger trees gradually crowd out the weaker. Too few trees on an acre result in bushy tops and knotty lumber; too many trees mean a slowing up of individual growth. There is a right number, varying with the age and location, to obtain the best growth of the largest number of trees. Thinnings are made when necessary to reduce the number of trees so as to obtain the maximum growth for the kind of product desired.

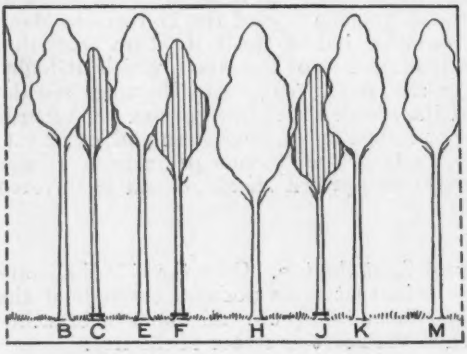
How should thinnings be made?

There are two ways of thinning pine stands. The whole subject of thinning slash pine stands is closely related to the working of trees for turpentine.

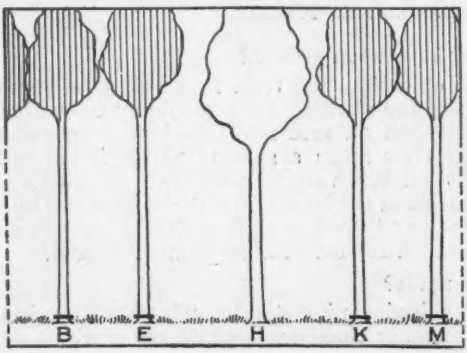
A so-called "low" thinning, as shown graphically in Figure 10, consists of cutting out the smaller, less vigorous, diseased, and unpromising trees. They may be worked first, but only if profitable. This method favors the largest and best trees and more nearly keeps the timber production at its capacity. Size and quality count much in the value of the timber.



Thinning.—Age of the trees, 5 to 10 years. A light thinning is to be made by cutting out the smaller, slower-growing trees, A, D, G, I, and L. This will still keep the bigger trees slightly crowded to force them to grow upward instead of growing outward and becoming bushy



Thinning.—Age of trees, 15 to 20 years. Another thinning is to be made now of the smaller, less vigorous and less promising trees, C, F, and J



Final cutting.—Age 30 to 40 years. The final cutting is made of all trees except one, H, a vigorous, bushy-topped tree, which is left to produce seed and restock the land. About three such trees are left growing on each acre until the land is well reset with young trees

FIGURE 10.—A good method of working, thinning, and later cutting the final crop of pine trees where turpentine and timber products are desired at intervals. The smaller, less vigorous, and defective trees of this even-aged stand are worked and cut out, giving space for the stronger-growing trees to grow. This is repeated a few years later. The cuttings produce fuel wood, crossties, small saw logs, or pulpwood. The final cut produces saw timber or piling of good size, good grade, and good value. The trees to be cut are shaded. The letters aid in identifying the trees

The first principle is to wait until the trees to be removed have reached a merchantable size, so that the thinning may at least pay for itself, or, better still, make a profit. The material removed may be used for firewood, pulpwood, excelsior wood, or small saw timber. An idea of the number of trees per acre in full timber stands at different ages can be obtained from the last column of Table 1. For best production of turpentine these numbers should be reduced one-half to two-thirds. Closely related to this subject is the plan of thinning and turpentining found on page 22, which should be considered along with this discussion. (Fig. 11.)

In a so-called "high" thinning, the larger trees are worked and cut, thus giving space for the smaller trees to expand. It is not an

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FIGURE 11.—The thinning and pruning shown here was done when the trees were too young, and was too heavy, resulting in greatly checked growth. For turpentine yields pruning side branches is bad practice. During slack time in one winter this farmer thinned 86 acres of dense sapling slash pines, from a stand of about 2,000 to 900 per acre. He then pruned off the lower branches, giving a clear trunk for about 7 feet. Pruning side branches favors clear trunks, desirable for poles, piling, and saw logs

uncommon practice of owners to work and cut the largest trees, because they are the first to become merchantable. What happens then is the recovery of the formerly stunted trees to a normal growth. This adjustment usually requires a number of years, during which there is a loss in the growing power of the land. Thinning by this method (of cutting out the largest trees) permits of a periodical money return every 10 years or so, a feature which appeals strongly to the farmer or other owner of timberland and is especially desirable when adapted to cutting timber, without turpentining it, for pulpwood, fuel wood, or other small-sized product.

TURPENTINING SLASH PINE

The growing of slash pine as a farm crop or, on a larger scale, as a commercial industry centers largely about its capacity for producing naval stores as well as sap pine wood.

For every dollar of profit made from the wood of slash pine there is likely a return of about $2 from the gum or crude turpentine. A too common practice has been to work slash pine trees as soon as they reached diameters from 6 to 8 inches, and after three to four years of working to abandon the stand. Usually the trees soon became greatly injured by fire, and in this manner second-growth slash trees have been extensively destroyed.

With the increase in the value of pine, modern practices of turpentining are improving. However, much pine timber is still being worked too small and too young, and chipping is generally made too deep into the tree and too wide up the tree. To keep pace with the keen competition that exists in the naval-stores industry the successful turpentine man needs to use methods that will give him the greatest possible gum yields, keep down the costs, and maintain the vigor of his trees. The growing scarcity of turpentine timber is causing timber owners to lease only to careful operators.

What are gum and naval stores?

When the sapwood of pine trees is wounded or chipped it "bleeds" a thick sticky liquid known as gum resin or crude turpentine. The gum is not, as often supposed, the sap of the tree. It is not drained from a store in the tree but is formed in small cells or ducts scattered in the sapwood. When cut or wounded, these increase greatly in activity in order to heal over the wound. The heartwood is dead, and if cut does not produce gum although it contains considerable hard resin.

It is well known in the South that this gum when heated in a still gives off a volatile liquid called spirits of turpentine, leaving a heavier thick residue which, upon cooling, solidifies to form rosin. In the days of wooden ships, these and other products, known as naval stores, were made and extensively used in calking and waterproofing the hulls as well as tarring the ropes.

How does slash pine rank in gum production?

Slash pine excels all other native pines in the quantity of gum resin or crude turpentine which flows from the trees when faced or worked.

Its gum when freshly exuded is clear and about the color of light-yellow honey. As compared with longleaf or "hill" yellow pine, its nearest competitor, slash pine yields from its gum and "scrape" a slightly higher percentage of spirits of turpentine and a higher grade of rosin. Beginning to run a little later in the spring than longleaf, probably because of the colder situation in low ground, slash pine keeps up a heavy flow until late in the season, considerably past the time when longleaf stops flowing; also in contrast to longleaf it produces only a little scrape. It is not uncommon to hear it said that slash pine is more likely to die from turpentining than is its associate, longleaf pine. Observations make it seem

probable that the basis for this statement is the capacity of slash pine for free production of crude gum.

What are some good practices in turpentining?

Practices that are generally recognized to be advisable as a means of getting the most revenue out of timber, consistent with conditions of labor and market, include the following:

(1) Work no trees under 9 inches in diameter (at breast height measured outside the bark). Trees to be removed in thinning young stands may be considered as exceptions to this rule.

Only small yields, with rarely any profit, are obtained from trees less than 9 inches in diameter. Beginning with a 9-inch tree, and working one low face at a time insures a high sustained yield over a

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FIGURE 12.—Good turpentining is shown. Only the larger trees, 10 inches or over, are being worked, with only one face per tree, and in two years the faces are only 32 inches in height. The cups were raised for the second year's working

period of years and the largest profit in the long run to both owner and operator. (Fig. 12.)

(2) Work only one face on trees from 9 to 15 inches in diameter, and never more than two faces on any tree.

(3) Advance streaks should be made preferably four to six weeks, and never less than two weeks, ahead of the regular chipping season.

(4) Use the cup method. Under no condition use the old and wasteful "box" method. Careful hanging of cups and aprons or gutters prevents waste. Do not slab off the bark at the base of the tree.

(5) Use a No. 0 hack, as this permits cutting streaks three-fourths inch deep and one-half inch up the tree, known as medium-light chipping. Conservative methods are more profitable than heavy workings for turpentine, which "dry-face" and destroy much timber.

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Low chipping, one-fourth inch in width, gives more gum than medium (one-half inch) or high (three-fourths inch) chipping over a period of three years or more. If timber is to be worked for only two or three years and then cut, a high chipping is more profitable. Low chipping is adapted for owners wishing to operate their timber continuously over a long period of years.

The depth of chipping (ranging from one-third to 1 inch) in slash pine shows but little difference in the yield of gum; but a great difference in the condition of the tree at the end of four or five years. Deep chipping, or over one-half inch, causes dry faces and injury to the wood near the faces. Also, the tree is weakened mechanically and more liable to be windthrown.

F210402

FIGURE 13.—If the crop is in much danger of burning, at the close of the season each tree is raked in order to give protection. Unburned land makes thriftier trees which yield more gum. Many operators are beginning to work their trees in "rough," or unburned land

(6) Hang the cups as low as possible to prolong the working life of faces.

(7) Chip a moderately narrow face—not more than one-third the circumference of the tree.

(8) Leave at least 4 inches of living wood as bars between the faces on all trees.

(9) If the crop is not well protected from fire, following the season's working rake the ground clean for a distance of 2½ feet on all sides from the base of each worked tree. (Fig. 13.) More and more working is being done under fire protection on "rough" land. This gives more gum and eliminates the expense of raking and burning.

What are some bad turpentining practices?

Unprofitable practices of working timber include: (1) Working too small trees (figs. 14 and 15), (2) chipping too deeply and too wide, (3) placing too many faces on trees, and (4) leaving insufficient width in bars between faces.

It is difficult for private owners and operators to break away from the custom of cupping very small trees and overcupping large ones. In their desire for immediate returns they sacrifice heavily in income, or "kill the goose that lays the golden egg." A case is known where slash-pine trees were cupped at 8 years old and the same trees back cupped seven years later. Frequently all trees are cupped down to 6 or 7 inches in diameter, 2 cups hung on trees down to 9 or 10 inches, and 3 cups hung on trees 13 inches and over by laborers who are paid on the basis of each 1,000 cups hung, or of each "crop" of 10,000 cups. Heavy working is wasteful practice, except for the purpose of clearing up land or thinning heavy stands.

The flow of gum appears to be generally in proportion to the size and vigor of the trees and the size of the face up to the point where the tree is faced too severely. Practical men in the turpentine industry are heard repeatedly expressing the opinion that a large per-

F226885

FIGURE 14.—Bad turpentining is shown. All the trees, including those of all diameters down to 5 inches, are being worked. The faces are deep and the aprons driven deep into the trees

centage of the smaller-sized trees now bled are too small to pay for the cost of operation. The almost complete loss by wind and fire of small trees during or after severe turpentine operations is another potent economic reason for adopting conservative methods.

YIELD OF GUM

How much gum and naval stores will a slash-pine tree yield?

A slash-pine tree, growing in an open stand worked with 32 streaks during the season and scraped, will yield as follows: If 9 inches in diameter (breast height), about 123 ounces; 10 inches, about 140 ounces; and 12 inches in diameter, about 180 ounces. Compare with these figures the yields of trees smaller than 9 inches, namely, 95 ounces from 8-inch trees and 80 ounces from 7-inch trees. In crowded or dense stands small trees run about one-quarter less for 9-inch trees and one-half less for 7-inch trees.

In units of naval stores the yield of slash-pine trees may be illustrated by the average 9-inch tree, which produces a little under 8

F230217

FIGURE 15.—Deep chipping and inserting of aprons often result in serious loss of timber and money returns. Such loss as this by wind and also dry facing are, fortunately, less common now than in the past

pounds (123 ounces) of gum, which will make about one-fifth of a gallon of spirits of turpentine and about 5 pounds of rosin; a 12-inch tree yielding 11.2 pounds of gum will make about one-third of a gallon of spirits of turpentine and about 7 pounds of rosin.

How much naval stores will a crop of slash-pine yield in a season?

There are 10,000 cups in a crop. Varying widely with conditions of size and vigor of trees, as well as the locality and the season, a crop of cups will yield in a full season from 100 to 400 barrels of gum. One dip barrel (50 gallons) of gum commonly yields from 10 to 11 gallons of spirits of turpentine; or it requires nearly 5 barrels of gum to produce 1 barrel (50 gallons) of spirits of turpentine. The size of the tree is an important factor. A crop of average open-grown trees, worked for 5 years with 32 streaks per year, chipped one-half inch deep by one-half inch high, with one face per tree should yield about as follows for different-sized

trees: A crop of 9-inch trees should produce about 42 barrels of spirits of turpentine; 10-inch trees, 49 barrels; 11-inch trees, 55 barrels; and 12-inch trees, 62 barrels. With these trees of regulation sizes, may be compared the amounts of naval stores yielded by crops of undersized trees, namely, 8-inch trees averaging 36 barrels and 7-inch trees averaging only 31 barrels. The latter yields are considered as unprofitable.

The amount of rosin produced at the same time is about 3¼ barrels to 1 barrel of spirits of turpentine. For example, a 50-barrel yield of turpentine at the ratio of 1 to 3¼ means a production of about 162 barrels of rosin. The foregoing indicates the reason why working small trees does not pay expenses.

Another factor, trees grown in dense stands yield about one-quarter less gum for 9-inch trees, one-sixth less for 12-inch, and one-third less for 7-inch trees.

What are some important factors about turpentining and naval stores?

A barrel or cask of spirits of turpentine contains 50 gallons. A gallon weighs about 7¼ pounds.

A barrel of rosin weighs gross about 500 pounds but contains net about 420 pounds of rosin.

About 20 per cent of the weight of the gum or "dip" from the cups is spirits of turpentine. An average of about 9 per cent by weight of the scrape is spirits of turpentine, although there is a wide variation.

The scrape from slash pine trees is relatively small in amount. It is about 6 per cent by weight of the total gum yield of the tree (dip and scrape). In contrast, the scrape from longleaf pine trees, if the cups are raised each year after the first, comprises about 24 per cent of their total product. Otherwise the scrape is relatively larger in amount.

About 40 pounds of dip are required to yield 1 gallon of spirits of turpentine, or about 5 barrels of dip (400 pounds of dip per barrel) to yield 1 barrel of spirits of turpentine. For each barrel of spirits there are produced on an average for the season's run about 3¼ barrels of rosin.

Advanced streaks are of much value in producing larger yields of gum, not only during the early chipping but throughout the season. Four to eight weeks ahead of the first regular streak is recommended as the time to make advance streaks.

Low chipping (that which removes from one-quarter to one-half inch in height by each streak for a season or two may result in less gum, but if continued over a 5-year period results in a larger yield of gum than high chipping through the period. Medium chipping of about one-half to three-quarters of an inch in depth gives the best results in slash pine. Deeper chipping, although for a time giving a higher gum yield, results in greater injury by checking growth and by windfall.

The flow of gum depends closely upon the weather. A hot spell and likewise a hot, rather dry season increase the flow of gum.

The larger the tree the larger the total yield of gum, other conditions being practically alike. Trees measuring under 9 inches in diameter (at 4½ feet above the ground) are doubtful money-makers.

The largest total production of gum from a tree is obtained by working only one face at a time, chipping low and moderately deep, and by nailing instead of driving the tins. The total yield by working two faces at the same time on trees up to 12 inches in diameter is only about 70 per cent as much as that obtained by working only one face at a time. Driving the tins increases dry face, insect attack, and blow down.

On the national forests in Florida turpentining rights are being leased to individuals or companies under the terms of a carefully drawn contract sale. Sample copies of the form used will be mailed upon application to the forest supervisor, United States Forest Service, Pensacola, Fla.

The Department of Agriculture has a number of publications dealing in detail with various phases of turpentining. Application should be made to the Office of Information, United States Department of Agriculture, Washington, D. C.

EFFECTS OF TURPENTINING AND FIRE

Does turpentining affect growth of the tree?

The rate of growth is greatly checked by heavy working. Careful turpentining in accord with conservative methods using one cup per tree generally checks the growth of slash pine trees from one-fourth to one-third of normal. Working two faces usually reduces growth one-half or more of its former rate. Following the working of the tree, a gradual recovery in rate of growth and a natural healing over the face takes place, faster in the more vigorous and healthy topped trees.

Along with the injury resulting from wounding and attendant loss of resin, it appears certain that exposure to fires and the injurious agencies of rot and insect infestation subsequent to turpentining have much to do with any decline in growth that may occur. In case this assumption be correct, it follows that slash pine, if rightly handled, may be turpentined to advantage in advance of the final working and harvesting of lumber.

Does burning affect the yield of turpentine?

A deep layer of straw (leaves), twigs, and dead grass is an effective mulch, conserving much-needed soil moisture and preventing overheating of the soil in midsummer. Under natural conditions the growth of trees thus protected is much faster than where burning occurs frequently. Since the yield of gum depends mostly upon the vigor of the tree, full protection against burning is very profitable. Raking the trees in the fall is a safety measure, and full protection against fire is being effected by an increasing number of operators. Anything which promotes the thrift and vigor of the tree increases the yield of gum. (Fig. 16.) Likewise, during long, hot summers the trees yield more heavily than during cool summers. Burning off the green leaves from young timber under a fire which was hot enough to kill most of the green leaves of pines being turpentined is known to have reduced the yield of gum to one-half that on adjacent unburned trees. (See also pp. 45 to 48.)

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FIGURE 16.— A profitable stand of slash pine. The farmer has kept out fire, and this 20-year-old stand is being worked continuously for turpentine. The farmer sells the gum to a near-by still

TURPENTINE MANAGEMENT PLAN

In simple terms, the problem of managing a stand of slash pine has as its main object obtaining the largest amount of gum, or crude turpentine, and then cutting the trees for pulpwood lumber or other product. In this connection pine wood is coming to have an increasing use and value for pulpwood.

What are the important steps in handling slash pine as a dual crop?

A stand of young slash pines may be regarded safe from ordinary ground fires when the trees are from 10 to 20 feet in height. Such trees will be from 6 to 12 years old. At this stage the stand may be thinned out so as to save the best trees evenly spaced, and from 200 to 300 per acre.

When the trees have reached heights of 50 to 60 feet, with diameters ranging from 9 to 10 inches, turpentining operations may be begun on all the trees except about 100 of the best developed and thriftiest trees left as evenly spaced as possible to form the final

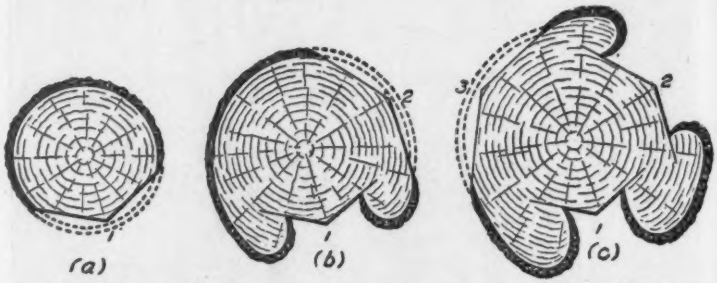


FIGURE 17.—The first working was begun when the tree (*a*) reached 10 inches in diameter (breast height). The second (*b*) was begun after a 3-year working and three years of rest; and the third (*c*) after similar periods of working and rest. Thus, the tree was worked 9 years during a period of 18 years. This method is one of very conservative working, resulting in a good growth of timber and high yield of gum. (The figures 1, 2, and 3 serve to identify the three faces)

timber crop. The trees may be worked for 3 years, rested a year, and back cupped for the next 3 years—making a work period of 7 years. (Fig. 17.) The worked trees may then be cut and utilized for one or another kind of product. The age of the remaining 100 trees will be from 25 to 40 years.

Slash-pine trees or stands, when protected and rightly handled, can be worked for turpentine with rest period from the ages of about 15 to 40 years, or longer. A well-stocked stand will average a growth of 1 to 2 cords of wood per acre per year during the period of from 10 to 40 years, or an equivalent of 300 to 800 board feet per acre yearly.

This brings the owner to the last stage of management, with an option of two courses either of which may be adopted. By one method the trees may all be worked as they grow, conservatively with one face at a time for a period of 6 to 20 years. If the alternative method is adopted, the trees are allowed to grow to a good size for lumber, say 15 to 18 inches, when they are worked heavily with two or more faces per tree, for three or seven years, in the latter

case including a year's rest. If the market is good one or two high workings may be added.

The time required to grow the crop, or the rotation period, as here outlined, will vary from 35 to 50 years, depending mostly upon the conditions of growth and market for the dual product of naval stores and timber.

The exclusion of fire during the life of the stand and the one or more openings of the stand due to cutting the worked trees should result in a good restocking of the land to young slash pines. In the event, however, of a failure in having a sufficient stand of young growth at the time for the final cutting of the mature tree crop, it would be necessary to make some special provision for that purpose. One good way would be to arrange for the cutting during the late fall or winter following the scattering of a full crop of seed or mast.

LEASING TIMBER FOR TURPENTINE

The rights to work trees for turpentine, often called a lease, are sold by timber owners to operators. The time is generally from three to five years, and the prices vary depending upon the market and the size and location of the trees. Prices generally run from 3 to 5 cents per face per year, which for a 4-year lease would range from 12 to 20 cents per face. If the timber is leased on a percentage basis the operator usually pays the timber owner from 15 to 25 per cent of the local value of the turpentine and rosin produced.

Turpentine Leasing Agreement for Farmers

In leasing out turpentine rights to timber it will pay the owner well to do it under a written and signed agreement. Such a contract, in fact, will result in safeguarding the interests of both parties. The essentials of such an agreement, as embodied here in the sample lease and applicable for the use of small owners, are based upon one used by the United States Forest Service in leasing its timber on the national forests. Such money items as the rental charge per face and others which vary locally and from year to year are inserted here merely as illustrations to make the form as clear as possible.

NAVAL STORES AGREEMENT

I, John Doe, of Pine City, State of Florida, hereby agree to work for naval stores certain timber on the lands owned by Richard Roe, Leesville, Fla. Said timber is all the slash and longleaf pine timber not excepted under the terms of this agreement located on an area of about 40 acres to be definitely designated by Richard Roe before cupping begins in section 9, township 4 north, range 6 east, Tallahassee meridian and base line, upon which it is estimated that 2,000 cups, more or less, may be placed. In consideration of the granting of this privilege to me for a term of three years I do hereby promise to pay to Richard Roe the sum of $300, more or less, as may be determined by actual count at the rate of $150 per thousand cups, payable on or before March 15, 1932.

And I further promise and agree to work said timber in strict accordance with the following conditions:

(1) No tree will be cupped, chipped, raked, or worked in any manner until payment has been made in accordance with the terms of this agreement.

(2) Title to the product of the timber included in this agreement will remain in Richard Roe until it has been paid for as herein prescribed and removed from the tree.

(3) No timber will be cupped except that on the area designated by Richard Roe, and all timber on that area will be cupped except as herein specified.

(4) No marked tree and no tree 9 inches or less in diameter at a point 2 feet above the ground will be cupped; not more than 1 cup will be placed on trees from 9 inches to 14 inches, inclusive, in diameter; not more than 2 cups will be placed on trees from 14 inches to 22 inches, inclusive, in diameter; and not more than 3 cups will be placed on any tree.

(5) The greatest depth of streaks will not exceed one-half inch, excluding the bark. The width of the streaks will be so regulated that not more than one-half inch of new wood will be taken off at each chipping. The faces chipped or pulled the first season will not exceed 15 inches in height from the shoulder of the first streak of the season to the shoulder of the last streak of the season, including both. The faces chipped or pulled in subsequent seasons will not exceed 15 inches in height, measured in the same way. A No. 0 hack or puller will be used for chipping or pulling. Bars or strips of bark not less than 4 inches wide in the narrowest place will be left between faces, and this width shall not be lessened as the faces progress up the tree. Where more than one face is placed on a tree, one bar between them will not exceed 8 inches in width. The first streak at the base of the face will be made at the time the apron or gutter is placed. Not more than one streak will be placed on any face during any week. Faces not chipped in accordance with these specifications may be marked out and the cups removed by Richard Roe.

(6) A cupping system satisfactory to Richard Roe will be used, and the cups and aprons or gutters will be so placed that the shoulders of the first streak will be not more than 6 inches distant from the top of the cup, and the cups first placed will be as near the ground as possible. No wood will be exposed on any tree by removing the bark below the gutter or aprons.

(7) No unnecessary damage will be done to cupped trees, marked trees, or to trees below the diameter limit. Trees that are badly damaged during the life of this agreement, when such damage is due to carelessness or negligence, shall be paid for at the rate of $6 per thousand feet board measure, full scale. Trees split or windthrown because of deep incisions for raised tins will be considered as being damaged unnecessarily.

(8) No cups will be placed later than May 15, 1932, without written permission from Richard Roe, and all timber embraced in this agreement will be cupped before said date. The cupping will proceed with all reasonable speed.

(9) Unless extension of time is granted, all timber will be chipped, dipped, and scraped, the product and all cups, aprons, gutters, and nails removed, and each cupped tree thoroughly raked to the satisfaction of Richard Roe not later than December 31, 1934. Tins will be pulled out, not chopped out.

(10) No fires will be set to the timber, underbrush, or grass on the area covered by this agreement without the written permission of Richard Roe, and during the time that this agreement remains in force I will, independently, do all in my power to prevent and suppress unauthorized forest fires on the said area and in its vicinity and will require my employees and contractors to do likewise.

(11) All cupped trees will be raked in a workmanlike manner for the space of 2½ feet around each tree during December of each year of the life of this agreement; and, if required by Richard Roe a fire line not less than 3 feet wide in the narrowest place shall be hoed or plowed around the area covered by this agreement in such a manner as to completely isolate it from adjoining lands. Natural firebreaks, such as creeks, swamps, roads, etc., may be utilized with the consent of Richard Roe. These fire lines must be made and receive the approval of Richard Roe before any cups are placed the first year or new streaks made at the beginning of each subsequent year.

(12) Richard Roe reserves the right to sell or otherwise dispose of and remove or have removed all dead timber and uncupped living timber from the area covered by, and during the life of, this agreement; provided, that the removal of such material will not interfere with the operations of the purchaser.

This agreement will not be assigned in whole or in part without the written approval of Richard Roe.

The conditions of the sale are completely set forth in this agreement, and none of its terms can be varied or modified except in writing with the approval of both parties.

And as a further guarantee of a faithful performance of the conditions of this agreement, I deliver herewith a bond in the sum of $500, and do further agree that all moneys paid under this agreement will, upon failure on my part

to fulfill all and singular the conditions and requirements herein set forth, or made a part hereof, be retained by Richard Roe to be applied as far as may be to the satisfaction of my obligations assumed hereunder.

Signed in duplicate this 20th day of December, 1931.

JOHN DOE,
(Signature of purchaser.)
Operator.
(Title.)

Witnesses (corporate seal, if corporation).
JOHN JONES.
TOM BROWN.

SCALING LOGS AND ESTIMATING TREES

What is a log scale rule?

A scale or rule which shows how many board feet can be cut from logs of various sizes. Most commonly, the diameter of the log in inches is measured inside the bark at the small end, and the length in feet over all.

Does it make any difference what log rule is used for measuring and selling logs?

Yes; a great difference both in the amount of timber and in the resulting money return.

The Doyle rule, although in common use in the South, is unfair to the seller for logs below about 28 inches in diameter. In the early days of large and cheap virgin timber, when narrow and knotty boards were worthless, it was fairly satisfactory, but for scaling small-sized timber, such as second-growth southern pine, it gives such small volumes for small logs as to make it unsatisfactory. On the national forests the Scribner rule (in the decimal C form) is standard. It is more fair than the Doyle rule for small logs, but reasonably careful sawing should result in obtaining from 10 to 20 per cent more lumber than even this rule gives for second-growth timber.

TABLE 2.—*The contents of logs, in board-feet, scaled by the international log rule (using saw cutting ¼-inch kerf)*

Diameter at top end of log inside bark (inches)	Length of log in feet						
	8	10	12	14	16	18	20
	Contents of log in board feet						
6	7	10	13	16	19	23	27
7	12	15	19	24	28	33	39
8	16	21	27	33	39	45	52
9	23	29	36	43	51	59	68
10	29	37	45	54	64	75	86
11	36	46	57	68	80	92	105
12	44	57	70	83	97	111	127
13	52	68	83	100	116	133	151
14	62	80	98	117	136	156	176
15	73	94	114	136	157	180	204
16	84	108	131	156	181	207	233
17	96	123	149	177	205	235	265
18	110	139	169	201	232	265	299
19	123	156	190	225	261	297	335
20	138	174	212	251	290	330	372
21	152	193	234	279	321	366	412
22	168	214	259	307	354	404	453
23	186	235	285	337	388	442	497
24	203	257	311	367	424	481	542

For small timber, such as second-growth pine, the International log rule (Table 2) gives log volumes which are very close to what can be sawed out by using good methods. Careless sawing will give a lower volume of square-edged boards than the logs scaled by this rule, so that it gives the millman a chance to test his own efficiency in this respect. Producers of small logs will benefit when this or some equally close rule has come into general use. The sale of logs by the International rule is recommended.

TABLE 3.—*The contents of logs, in board-feet, scaled by the Doyle log rule*

Diameter at top end of log inside bark (inches)	Length of log in feet						
	8	10	12	14	16	18	20
	Contents of log in board feet						
6	2	2	3	3	4	4	5
7	4	5	7	8	9	10	11
8	8	10	12	14	16	18	20
9	12	16	19	22	25	28	31
10	18	22	27	31	36	40	45
11	24	31	37	43	49	55	61
12	32	40	48	56	64	72	80
13	40	51	61	71	81	91	101
14	50	62	75	87	100	112	125
15	60	76	91	106	121	136	151
16	72	90	108	126	144	162	180
17	84	106	127	148	169	190	211
18	98	122	147	171	196	220	245
19	112	141	169	197	225	253	281
20	128	160	192	224	256	288	320
21	144	181	217	253	289	325	361
22	162	202	243	283	324	364	405
23	180	226	271	316	361	406	451
24	200	250	300	350	400	450	500

As a comparison, a log measuring 10 inches in diameter inside the bark at the small end and 16 feet long, when carefully sawed with a circular saw of ordinary thickness (1/4-inch kerf) should, according to the International rule, turn out 64 board feet. For the same log the Doyle rule (Table 3) would show 36 board feet or only about one-half the amount that can be actually sawed and that is credited to it by the International rule.

How are logs scaled?

The diameter of the small end of the log inside the bark is measused in inches, and its length is taken in feet. If a scale stick is used, the contents of the log are read directly from the stick. These readings are for straight and sound logs. Thus the scaling of sound and straight logs is a simple matter. (Fig. 18.) Experience and special knowledge are required to determine the allowance that should be made for defective logs. Slash pine logs average high in freedom from rot.[7]

How many board feet of saw timber can be cut from pine trees of various sizes?

Much depends upon the degree of care exercised, the kind of saw used, and the amounts taken from, and left in, the woods. The

[7] For more information regarding how to scale logs and estimate standing timber consult Farmer's Bulletin 1210, Measuring and Marketing Farm Timber.

International rule (Table 2) shows what can be sawed from logs with a circular saw cutting a ¼-inch kerf, all the usable lumber being taken. This rule, applied to slash pine trees, shows not what is now being cut by wasteful methods but what should be taken to meet the present conditions of scarcity and high price of lumber.

FIGURE 18.—Logging mature slash pine in the flatwoods of northern Florida. Because of the similarity of the woods, slash pine is cut and marketed without distinction along with longleaf pine. Note the large amount of damage to standing timber by repeated forest fires

To estimate the board-foot contents of a tree, the diameter outside the bark (at breast height, or 4½ feet above the ground) and the number of 16-foot log cuts are ascertained. For example, the contents of a 14-inch tree having three 16-foot cuts is about 129 board feet. (Table 4.)

TABLE 4.—*Saw timber contained in slash-pine trees of various diameters and log lengths if cut and utilized closely. (Cut with circular saw.)*[1]

Diameter of tree at breast height outside bark (inches)	Number of 16-foot logs				
	1	2	3	4	5
	Contents of tree in board feet				
7	18	27	42	----	----
8	20	34	52	----	----
9	23	39	63	88	----
10	25	44	76	106	139
11	----	51	88	125	166
12	----	57	101	146	192
13	----	62	115	170	221
14	----	70	129	187	250
15	----	76	143	211	282
16	----	83	160	234	314
17	----	----	177	261	348
18	----	----	193	287	384
19	----	----	212	315	422
20	----	----	231	345	463

[1] Logs scaled by the International log rule.

Various kinds of tree-scale sticks, or "cruising" sticks, are coming into use. They are used to measure the diameter and the height, or the number of logs, in a tree. One is known as the Biltmore stick. Some of the sticks also show for trees of different diameters and number of 16-foot cuts, the number of board feet of saw timber than can be cut out. Information as to sources of tree-scale and log-scale sticks and their use can be obtained from your State forestry department, the extension service of your State college of agriculture, or the Forest Service, U. S. Department of Agriculture.

TIMBER PRODUCTION PER ACRE

Many stands of shortleaf pine of known ages have been studied and measured to find out how much timber they will yield per acre. In this the forester deals with fully stocked stands, or those which have no blanks or spots without trees. The quantity of timber is measured in the standing trees, either in cords, crossties, or lumber. With the figures so obtained it is possible to predict the rate of growth and the quantity of timber there should be on an acre at different ages.

How many cords of wood will an acre of slash pine produce?

A fully stocked stand of slash pine 20 years old on poor land should cut out per acre about 20 cords (with the bark on); on average land about 35 cords, and on good land about 46 cords. (Table 5.) The average growth is thus from 1 to 2 cords per acre per year in peeled wood, such as is often wanted for paper pulp and excelsior. It will be seen in Table 5 that an acre of average land will produce slightly more than a cord a year in stands between the ages of 15 and 50 years; also the highest average rate of production of cordwood comes very early when the trees are not older than 15 years.

The number of trees at any given age required to cut a cord can be easily calculated from the last column of Table 1. For example, at 20 years of age on average land, fully stocked slash stands contain about 150 trees per acre. If the stand on average land at that age cuts about 35 cords (column 3 of Table 5), the average tree will cut out about one-fifth of a cord, or it will require about five trees to make a cord.

How much saw timber will an acre of slash pine produce?

The owner or the prospective buyer of timberland should know its capacity for producing timber. Fortunately, the amount of slash pine timber that can be grown per acre can be predicted because of studies which have been made of many well-stocked, well-set, or dense stands. Table 6 shows the amount of saw timber that stands may be expected to cut at various designated ages. The figures do not include the timber removed in previous thinnings, or the intermediate yield, often a very considerable amount. It is regretted that the rate of timber production for unburned stands is not known, as it would be somewhat larger.

TABLE 5.—*Cordwood yield per acre of slash pine at different ages, in well-stocked stands, or about maximum yields* [1]

Age of trees	Wood with bark			Peeled wood		
	Good land	Average land	Poor land	Good land	Average land	Poor land
Years	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*
15	37	27	12	29	20	9
20	46	35	20	35	25	14
25	53	42	26	41	31	18
30	59	48	32	47	37	23
35	66	54	36	53	42	27
40	72	58	40	58	45	30
45	77	62	43	62	49	32
50	81	65	45	66	51	34
55	84	67	47	68	54	36
60	86	69	48	71	56	37

[1] Includes the wood from all trees 4 inches and over in diameter.

An acre of average-grade land well set in slash pines—for example, 30 years old as shown in Table 6, column 3—should cut out an average of 11,800 board feet if all the trees measuring 7 inches and over are carefully sawed. This is an average growth in round figures of 400 feet yearly. If the logs were scaled by the Doyle rule and only the trees that measure 9 inches and over in diameter at breast height were counted, the timber on the acre would scale only about 1,500 board feet. But the scale shown by the Doyle log rule is too low, and the cut would actually be more.

TABLE 6.—*Saw-timber yield per acre in board feet at different ages from full stocked slash pine stands*

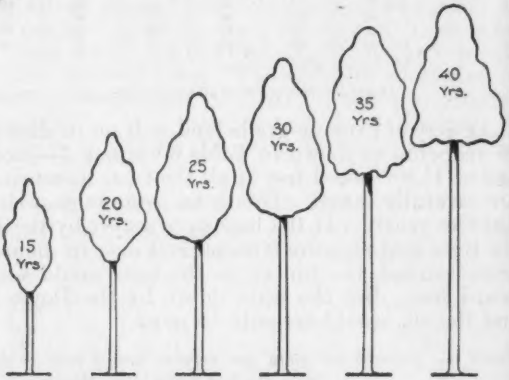
Age of trees	Lumber yield in board feet					
	Actual cut by careful sawing [1] (mill tally)			Logs scaled by the Doyle rule [2]		
	On good land	On average land	On poor land	On good land	On average land	On poor land
Years	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
15	4,900	1,400				
20	9,500	3,600	450	1,000		
25	15,800	7,200	1,800	3,500		
30	21,700	11,800	3,600	7,000	1,500	
35	26,700	15,800	5,400	11,000	3,500	
40	31,200	19,900	7,700	14,500	6,000	500
45	34,800	23,100	10,000	17,500	8,000	1,500
50	37,100	25,300	11,800	19,500	10,000	2,000
55	39,400	27,600	13,100	21,500	11,500	3,000
60	41,200	29,000	14,500	23,000	12,500	3,500

[1] All trees 7 inches d. b. h. and over, per acre, International ¼-inch saw kerf.
[2] All trees 9 inches d. b. h. and over, per acre, Doyle log rule.

Slash pine, when grown in well-set or dense stands and protected from fire, should grow on the lower grades of land, or situations, 1 cord a year per acre, or from 300 to 500 board feet a year per acre. Such well-set and protected stands on average to good grade lands should grow up to 2 cords an acre yearly, or from 500 to 800 board feet.

At 40 years a fully stocked acre of slash pine (Table 6) on good land should cut about 31,200 board feet, an average of 780 board feet per year; on average land 19,900 feet, or an average growth of about 500 board feet yearly; and on poor land about 7,700 feet, or an average yearly growth of 192 board feet. (Fig. 19.) These illustrate well the wide differences in growth due to different conditions of soil, soil moisture, and climate. Conditions often vary widely in the same locality.

A caution here is advisable. These figures show what would be the yield if all the trees were sound and straight. A slight allowance for seen and unseen defects in the logs is necessary, or the scale will be somewhat too high.



AVERAGE						
HEIGHT OF TREE (feet)	39	48	56	63	69	73
DIAMETER, breast height (inches)	7	8	9½	10½	12	13
BOARD FEET PER TREE	9	20	42	66	105	133
CORDWOOD PER ACRE (with bark)	27	35	42	48	54	58
SAW TIMBER PER ACRE (board feet)	1,400	3,600	7,200	11,800	15,800	19,900

FIGURE 19.—Average size of slash pine trees, their contents in board feet, and the amount of cordwood or lumber per acre at various ages. (See Tables 1, 5, and 6).

What are some examples of stands actually measured?

The following essential facts concerning a few of the stands actually measured will serve as an illustration of what yields per acre may be expected from well-stocked slash-pine stands, such as are locally considered to be dense stands.

(1) A 21-year-old stand, consisting of 384 trees per acre, averaging 8 inches in diameter at breastheight and 56 feet in height, contained 45 cords of wood with the bark on, or 34 cords of peeled wood. If all trees measuring 10 inches and over in diameter were cut, the stand would saw out about 6,400 board feet; or if all trees 8 inches and over were taken, it would saw about 10,300 board feet. By the Doyle log rule, however, all trees measuring 8 inches and up in diameter would scale only 3,700 board feet. This was on good land, giving about maximum yield.

(2) A 25-year-old stand, with 274 trees per acre, averaging 63 feet in height and 9 inches in diameter, contained 47 cords of wood with the bark, or 37 cords of peeled wood. The trees 10 inches and over in diameter would saw out, down to small top diameters, about 10,700

board feet per acre; or about 13,500 feet would be obtained if trees 8 inches and up in diameter were taken. If the logs in the trees measuring 8 inches and over in diameter were scaled by the Doyle rule, there would be only 5,800 board feet per acre.

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FIGURE 20.—Natural regeneration of slash pine: A.—Good stand of slash pine resulting from plenty of seed and protection from fire; B.—Too heavy cutting for pulpwood, leaving no thrifty bushy-topped seed trees to restock the land

(3) A 26-year-old stand, with 754 trees per acre, would cut 64 cords of wood with the bark, or 47 cords of peeled wood. There would be a total of only 1,300 board feet if trees measuring 10 inches

and up were taken; or 8,000 feet from all trees 8 inches and over in diameter, as compared with only 1,360 feet by the Doyle rule.

(4) A 30-year-old stand, with 114 trees per acre, averaging 11 inches in diameter and 69 feet high, contained 31 cords with the bark, or 25 cords of peeled wood. There would be 9,672 board feet per acre of saw timber in the trees 10 inches and over in diameter, or 10,700 board feet in the trees 8 inches and over in diameter. If scaled by the Doyle rule, the stand had only 5,700 board feet.

(5) A 51-year-old stand, which consisted of 220 trees per acre, averaging 70 feet in height and 9.4 inches in diameter, contained 57 cords of wood with the bark, or 44 cords of peeled wood. The stand would cut out 10,100 board feet from all trees 10 inches and over in diameter, or 14,600 feet from trees measuring 8 inches and over. The Doyle rule gave only 5,900 feet of saw timber.

REFORESTATION BY NATURAL METHODS

The natural restocking of slash-pine lands with young growth may be expected to take place satisfactorily whenever sufficient seed trees are left in logging. Young slash pine rapidly takes possession of old fields, wet lands, vacant lands near towns, and on places protected from fire. Such reforestation, however, is not proceeding everywhere on account of carelessness in too heavy cutting and occasional fires. (Fig. 20.)

There are still large areas of practically idle land in the South which should be growing timber. Many owners of small tracts and some owners of large ones are, however, seeking information and are taking active steps toward getting young pine growth to come back on their lands.

Where do the seeds come from?

From the cones, or burs, which mature and open in the fall. Each scale bears two seeds in hollows, or pockets, at its base, which may easily be seen upon examining an open bur. However, scales near the tip and base of the bur commonly do not bear fertile seed. The burs start from very small female flowers that have been fertilized by pollen from the male flowers, and they require two seasons to mature. The pines all bear male and female flowers separately, but both kinds on the same trees.

How much seed do slash pines produce?

Slash pine is a somewhat heavy seed producer. Full or heavy seed crops may be counted on at intervals of two to three years, although some seed is borne almost every year. Well-developed cones, or burs, have been observed on trees 12 years old, but in general trees growing in the open produce seed only after reaching the ages of 15 to 18 years. In close stands seed production is usually limited in quantity and begins at a little later age. The seed is small and provided with a wing by which it is easily carried on moderate winds two or three times the height of the tree for much greater distances. (Fig. 2.) As a result the seed is widely dispersed.

The number of seeds in a pound varies much but averages about 15,500, with approximately 80 fertile seed in every hundred. There are about 215 ripe closed burs in a bushel, which weigh about 34

pounds. A bushel of burs will yield about 1⅕ pounds, or 18,600 seeds, an average of 87 seeds per bur. In size and appearance the seed of slash pine closely resembles that of loblolly pine, with which it is likely to be confused. The wings of slash pine seed are easily removed—more easily than those of any other kind of southern pine.

Can the seed be kept in storage?

Slash-pine seed retains its vitality well in storage. The best-known storage is to place the seed, after thoroughly drying it indoors, in tight containers and keep it at as low a temperature as can be found, preferably in cold storage at a temperature of about 32° to 35° F. If cold storage is not available, the cans or jars might well be kept in a vegetable cellar or pit. The latter storage is satisfactory for seed kept over the first winter; the former should be used to keep seed for use the second spring after collecting.

When and where do the seeds germinate?

Slash-pine seeds, like longleaf, mostly germinate in the fall within a month after they reach the ground. If the seed crop is heavy and the fall rains favorable, as they are at intervals of every few years, full stands of young trees result. Conditions favorable for protection from fire also accounts for the abundance of slash pine in moist situations and its relative scarcity on dry soils. The broad margins of bodies of water, grass bogs in swamps, and flatlands liable to be water-soaked for some time are favorite situations for slash pine reproduction. Cultivation of abandoned fields disintegrates the underlying hardpan and affords moisture conditions favorable for seed beds. Young slash pine growing on such fields is commonly termed "old-field" pine. Fires, which fortunately are becoming less common and less severe, are still destroying vast numbers of young pines of the different species.

Can slash pine be grown successively as a crop?

With a kind of tree which seeds as abundantly as does slash pine, there is very little difficulty in growing one crop after another on the same land. Two necessary requirements for establishing a young stand are an adequate supply of seed on open ground and protection against fire. Like all the pines, the best production of slash pine comes from having even-aged trees in fairly close stands.

If a stand of pine trees is cut clean there will be little or no young growth, except where the trees are cut in the fall after the ripening of a good crop of seed. Since logging usually breaks up the surface soil the ideal time to cut the final crop or stand of trees would be during the two or three weeks while the ripened burs are opening in early fall. This would be just ahead of the period of seed germination and establishment of the young tender seedlings. Reference might well be made to the subject as found on page 35.

PLANTING SLASH PINES

The absence of seed-bearing trees sometimes makes it necessary to start young forest growth by means of so-called artificial reforestation. This is merely getting a stand of trees started either by

transplanting small trees or sowing the seed on the land. Slash pine is well adapted for reforesting lands by either method, but more especially by the planting of young seedlings. Young slash pines have small taproots and stand transplanting well if ordinary

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FIGURE 21.—Reforesting land by sowing pine seed: A.—Slash pine seed were sown here in 1-year rough grass on wet "crawfish" land in the coastal plain of South Carolina; B.—12 years later the slash pines were 30 feet in height and 5 to 6 inches in diameter at breast height. The stand now needs thinning and the trees can be used profitably. The arrow identifies the same stump in both pictures

care is taken, as shown later. Slash pine is apparently capable of being extended to a considerable distance beyond the limits of its present natural range.

Is direct seeding of land advisable?

Only under special conditions. In wet or "crawfish" land in the coastal plain of South Carolina and Georgia, satisfactory results have been obtained by direct sowing of slash pine seed. Early November sowings have proved more successful than those made in late March or early April. Sowings made with about 2 pounds of seed broadcast in 1-year rough grass, on low, poorly drained lands have given satisfactory stands (fig. 21); also fair stands have resulted from sowing 1 to 1½ pounds of seed, in hoed spots with 10 seeds to the spot and 1,000 spots per acre. A fairly open stand of grass acts as a protection against sun and wind in affording moisture in the air and modifying extremes of temperature. Pine seed should never be covered more than very slightly.

In seed-spotting low wet land a good method is to scatter 8 to 10 seeds on loose soil and press them in with the foot without any, or a slight, scattering of soil over them. Owners of recently abandoned pieces of farm land can expect satisfactory results from broadcasting 1 to 2 pounds of slash pine seed in the late fall and harrowing them in like a grain crop.

However, the seed-sowing method is regarded generally as uncertain and less satisfactory than the planting of small tree seedlings. If successful as to germination, the method requires considerable labor in thinning out the excess seedlings in order to secure a stand of uniform density. If a dry period follows the sowing, germination may be so delayed as to result in a loss of the seed by insects, mice, or birds. This result has been reported as prevailing in the lower parts of the States bordering the Gulf of Mexico.

Direct seeding of slash pine might well be tried on a small scale or experimentally on wet flatlands or low old fields by landowners interested in securing another crop of trees.

Is the planting of small trees a good method of reforesting land?

Yes; it is in general practice in the coastal plain—the home of slash pine. Slash pine is one of the easiest of all the pines to grow from seed and set out much like setting cabbage or tobacco plants. Successful and extensive plantations of 1-year-old seedlings have been made in the coastal plain of South Carolina, Georgia, Florida, and Louisiana. In the latter State one lumber company has more than 12,500 acres of hand-planted young slash pine forest.

HOW TO GET PINE SEEDLINGS

How can slash-pine seedlings be obtained?

Small year-old seedlings of slash pine can sometimes be found and dug up in old fields near mature seed trees, grown in a nursery bed at home, or purchased at nominal cost from the State forestry departments of the various States. Seedlings that have grown in sod or tight soil have poor root development and generally give unsatisfactory results. If the acreage to be planted is large, it will likely pay to establish a local nursery and grow the trees. In any case it is advisable to write to the State forester of your State forestry department, or apply to the local county agent for advice and publications on how to get a supply of seedlings, and

how to plant them. Applications for seedling trees should be made to the State forester several months in advance of midwinter or early spring—the best times for planting. Your county agent is in a position to assist you in all phases of timber growing as a crop on the farm, as he is in touch with the State extension forester. There are State or United States Department of Agriculture publications on nearly every phase of reforestation available free upon request to your State forestry agencies, or to the Forest Service, Department of Agriculture, Washington, D. C.

Where can one get slash-pine seed?

Pine seed may be collected from the trees, or purchased from some of the State agricultural colleges or from commercial seedsmen. It is usually an advantage to plant seed grown in the locality or near-by region. Information about crops of slash pine seed will be found on pages 32 and 33.

The seeds begin to ripen and the burs turn brown in early fall. After the burs have turned one-half brown, the collection should begin and may be continued up to the time the burs open. This is a period of three to five weeks. Pine seed is most economically obtained from tops of trees felled in logging. The burs should be pulled off and collected in gunny sacks, buckets, or tubs, and later spread out to dry on a tight floor or on canvas or sacking in the sun. In drying weather they will open in a few days, and if stirred or shaken the seeds will fall out. Each seed has a wing, and the mass of seed should be winged by rubbing over a screen or between the hands and then winnowed in a steady gentle breeze or in a grain fanning mill. Seed with the wings on are unsatisfactory for direct seeding or use in nursery beds.

Commercial prices of seed range mostly from $5 to $7 per pound. In good seed years, supplies of seed may be collected and cleaned at a cost of not more than $2 per pound, if logging operations are under way so that burs can be picked off the tops of trees felled in logging. If the trees have to be climbed for gathering the burs, the cost may go up to $3 or more per pound. Often the burs can be had by paying collectors from $0.75 to $1.25 per bushel, depending upon the abundance and ease of collecting. Following the tropical hurricane of early October, 1928, burs were obtainable in abundance for 50 to 75 cents per bushel. A bushel generally yields from 1 to 1¼ pounds of good seed. Occasionally, in dry years, pine seeds do not fill out well and are of poor quality.

How can one grow pine seedlings?

Of the various types of nursery beds one form is well adapted to slash pine. It consists of an ordinary bed, flat or even with the paths, or slightly raised and bordered by a curbing of 1 by 4 inch boards set 2 inches in the ground, thus holding in the soil. A width of 4 feet is standard for pine-seed beds. (Fig. 22.) A sandy type of soil is much better than clay soils.

The soil should be worked well in the fall and again in the spring. Acid soils are very desirable, as damping-off fungi are common and thrive in alkaline or sweet soils. On farms the beds should preferably be located near the house, so as to be easily watched and tended, and a supply of water for use during extra dry spells is desirable,

especially during seed germination. All large nurseries must have adequate watering systems.

In early spring slash-pine seed should be sown evenly in well-prepared beds at the rate of a pound (about 15,500 seeds) to each

FIGURE 22.—Growing slash pine seedlings in nursery beds: A.—One-year-old trees in Georgia State nursery ready for planting. A full stand has about 50 seedlings per square foot. B.—Small farm nursery bed of yearling seedlings in northern Florida, being viewed by interested visitors

4 by 20 foot bed. The seeding should be broadcast or, if preferred, in drills spaced 3 inches apart. The purpose is to produce a crop of about 75 thrifty seedlings per square foot, or 6,000 per bed 4 by

20 feet in dimension. Losses may be expected due to infertile seed, fungi, and insects.

After being sown the seeds are pressed into the soil by a roller, plank, or spade, and then covered very lightly with sand and a single layer of burlap (gunny sack) or by a medium layer of fine woods litter. The material should be as free as possible of weed seed. Silt or sand from stream banks is well suited for use in nursery beds.

How should nursery beds be protected and cared for?

The sown beds should be watched closely, carefully protected, and watered in case of hot dry weather. The period during the germination of the seed is especially critical, when an adequate supply of water will often mean the difference between success and failure. If a burlap cover is used, it should be removed as soon as the seeds begin to germinate, as the seedlings rise in the seed shells much as do those of cucumbers and watermelons.

Birds, mice, and insects are likely to be pests. A shotgun, traps, and poison are means of fighting these enemies. The period of germination of slash seed is usually two weeks or less, so that expensive wire-screened frames over the seed beds are not regarded as necessary. Shading by screens also is unnecessary in a slash-pine nursery. Ants sometimes cause much damage. A simple poison as bait can be used. Moles sometimes cause trouble and may be kept out by encircling the bed with a narrow trench filled with lime, or by sinking a strip of half-inch wire mesh to a depth of 1 foot around the bed. The damping-off fungi are likely to attack the tender stems just below the surface when the seedlings are up to 2 weeks old. Better ventilation and drying of the surface soil is helpful. Acid soils are the best for pine nurseries, therefore never apply lime as a deterrent to this class of injurious fungi.

For further information on fighting any pests of the nursery, application should be made to your local State forester or to the United States Department of Agriculture, Washington, D. C.

All weeds should from the start be pulled out when small, otherwise weeding will greatly injure the small pines. Watering during hot dry spells is very advisable. A dense stand of seedlings such as should be growing in the beds require much soil moisture. A gentle but thorough watering at intervals is much better than a mere surface wetting every day, and requires less time.

HOW TO PLANT PINE SEEDLINGS

When is the best time to plant pine seedlings?

In the early spring before the buds begin to swell the conditions are most favorable for planting slash pine seedlings. Late fall planting may give good results if the season happens to be wet and the winter mild, but much injury may be expected during a dry fall and during a severe winter, because of hard freezing and the resulting upheaval of the soil. If planted in the late spring after the new growth has started, pine seedlings are likely to make a poor growth or die during dry weather.

What are the important steps before planting pine seedlings?

One-season-old slash pine seedlings are best for planting. At the end of one growing season they should be from 8 to 10 inches in height—sometimes higher.

FIGURE 23.—A slash pine nursery of a Louisiana lumber company: A.—Digging, or lifting 1-season-old slash pine seedlings. The soil is carefully loosened and the trees lifted without injuring the roots. B.—The roots and stems are wrapped in wet sphagnum moss or in burlap, and the bundles are placed in crates for delivery at the planting places. In this nursery of a large Louisiana lumber company 7,000,000 slash pine seedlings were grown

The seedlings should be carefully dug and lifted from the nursery bed in order to avoid as fully as possible breaking the fine rootlets.

(Fig. 23, A.) All underdeveloped seedlings should be thrown away as culls, since it is an expensive mistake to plant spindling or sickly small trees. The taproot, if over 8 inches long, should be pruned back with a sharp knife. It is of the utmost importance that the roots at all times be kept wet; hence the dug seedlings should at once be placed in tubs or buckets with water, or wrapped in wet moss or gunny sack. (Fig. 23, B.) If not wanted at once for planting, the seedlings should be heeled in, in fresh soil, always in a cool, shaded place, and the soil never allowed to dry out. The leaves should be left freely exposed to the air but not to direct sunlight.

Some preparation of the soil for planting is often helpful. If the land is rough with stumps or bushes, the trees may be planted without soil preparation. A good method in open ground with heavy grass is to run furrows to break up the soil and mark off the land. The trees are then set in the furrow at regular intervals.

In planting slash pines with the purpose mainly of producing a turpentine orchard a wider spacing should be used than in planting

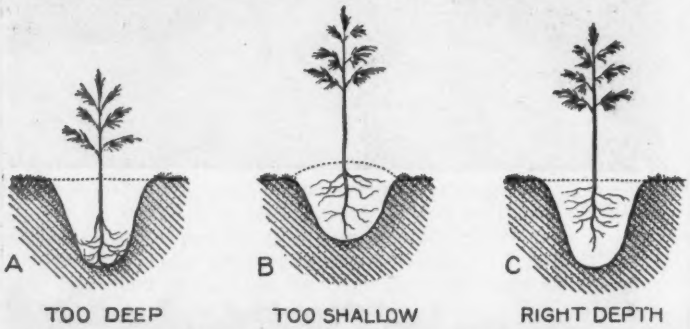

FIGURE 24.—The seedling trees should be set a little deeper than they grew in the nursery or woods as shown in C. Doubling up the taproot as in A is extremely injurious and if set too high, as in B, the tree is likely to fall over in a wind or dry out and die

for the largest possible crop of timber. A common practice now in the South is to plant seedlings about 5½ feet apart in rows or furrows spaced 8 feet, requiring 1,000 trees per acre. If every alternate tree is cut later in a thinning (perhaps at an age of 10 to 15 years) a stand of 500 trees is left. On small areas on farms this spacing seems favorable. In planting large areas a wider spacing is usually made. Trees planted every 8 feet in rows or furrows spaced 8 feet apart give a favorable stand of 680 trees per acre. A method described on page 43, that is being used in old fields in south Georgia with heavy growth of broom sedge, spaces the trees 5 feet apart in rows 10 feet apart, forming a stand of 870 trees per acre. This gives a driveway between rows for use in later turpentining operations when it is planned to work and cut out every other tree in the furrow.

How should pine seedlings be planted?

The essential aim of good planting is to get the trees firmly set in the ground, a little lower than they stood in the nursery, with

the least possible injury to the fine rootlets. (Fig. 24.) The roots must always be kept moist during planting and spread out in the hole or slit rather than bunched. Afterwards the soil should be well firmed about the tree to avoid rapid drying of the soil. From an economic point of view it is desirable to use some relatively inexpensive method. Two kinds of tools for making the planting holes are in use, namely, the mattock, or small grub hoe, and a special tool known as a dibble.

A good method of planting small pines is for two men to work together as a crew—one making the holes and one carrying a bucket

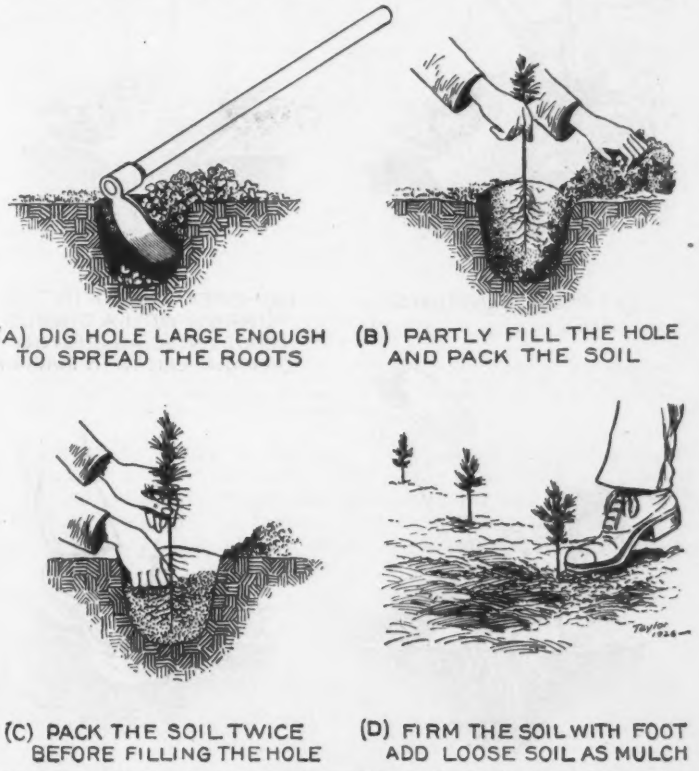
(A) DIG HOLE LARGE ENOUGH TO SPREAD THE ROOTS
(B) PARTLY FILL THE HOLE AND PACK THE SOIL
(C) PACK THE SOIL TWICE BEFORE FILLING THE HOLE
(D) FIRM THE SOIL WITH FOOT ADD LOOSE SOIL AS MULCH

FIGURE 25.—How to plant pine seedlings with a mattock or grub hoe in land that is not furrowed. Trees may also be planted in this manner in the bottom of furrows in soil that is not loose or not easily windblown

of trees and planting them. The bucket should have water or better a clay puddle. A two-man crew using a mattock in average sandy soil can plant 1,000 to 1,200 trees a day, or using a dibble and under good organization of the work, from 1,200 to 2,000 trees. In using the mattock the holes are often dug larger than is necessary. They should be dug, as shown in Figure 25, only a little larger than is needed to spread out the roots in a natural position, with the tap-

root straight down. The soil is then scraped in about the tree, which should be set a little deeper than it grew in the nursery bed or woods, and well firmed with the foot (sole or heel of shoe) so as to prevent drying out. Some straw, grass, or loose soil scraped

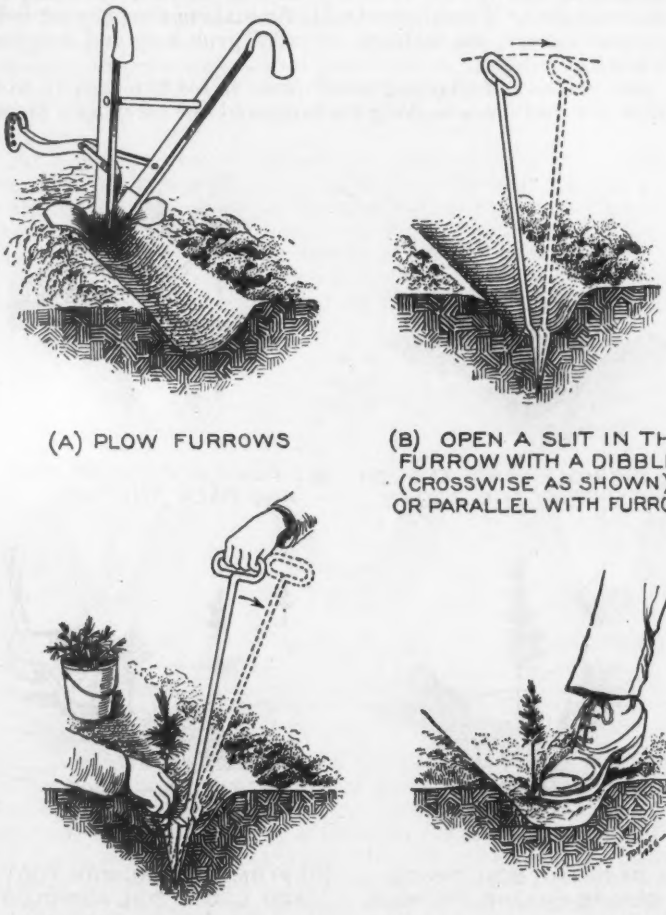
(A) PLOW FURROWS
(B) OPEN A SLIT IN THE FURROW WITH A DIBBLE (CROSSWISE AS SHOWN) OR PARALLEL WITH FURROW
(C) HOLD TREE IN THE SLIT CLOSE IT AT THE BASE
(D) CLOSE TOP OF SECOND SLIT WITH THE FOOT

FIGURE 26.—How to plant small pines, using a dibble. This is a rapid method applicable in sandy soils, and requires two men or a man and a boy. One uses the dibble, and the other carries a bucket of seedlings and holds one at a time in the slits. The dibble method is often used without furrowing the soil, especially where the grass cover is not heavy

about the tree will be helpful in acting as a mulch against rapid drying.

In loose, open soil the dibble may be used to good advantage, as shown in Figure 26. It is a straight, thin blade of iron on a handle

(fig. 27) and is used to open a slit and to close it after the little tree has been set in the slit.

In loose soil two men or a man and a boy should set an average of more than twice as many as by using a mattock in firm soil. In old fields and with thin grass, furrowing may not afford any advantage

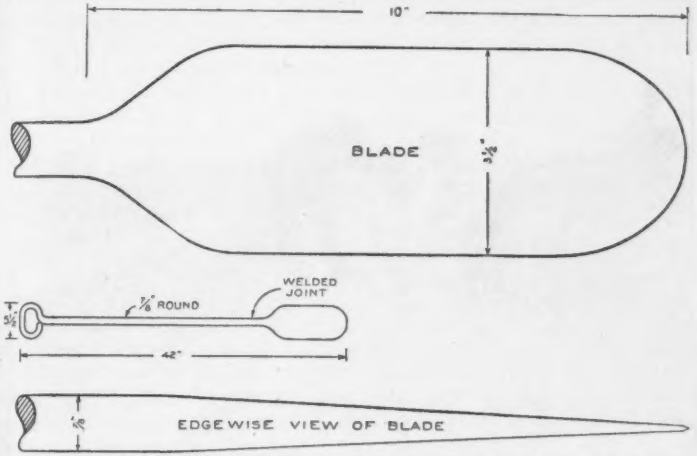

FIGURE 27.—A good tool for planting small forest trees is the dibble. The blade is of steel, 3½ by 10 inches, and tapers in thickness as shown from ¾-inch down to an edge. The handle is of ⅞-inch iron and welded to the blade. Various forms of dibble are for sale at hardware stores

or not enough to justify its expense. In the sandy lands of southern Georgia, with a cover of heavy broom sedge, a method of planting slash pines has been developed that promises good success. Figure 28 illustrates the method. A furrow is first made with a 4-inch scooter plow (or Harney stock plow). Next two broad furrows are turned

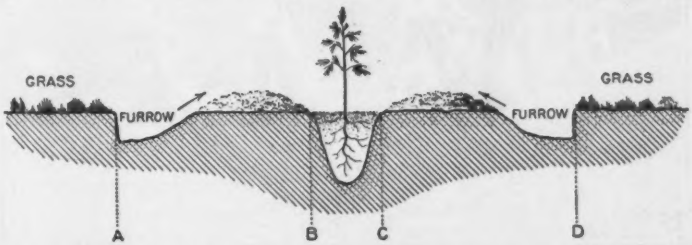

FIGURE 28.—Method of planting pine seedlings in heavy grass land by double-furrow preparation. Center furrow run with a 4-inch scooter plow, and two furrows made with a turning plow. This method checks competition from weeds and grass and conserves soil moisture. Distances: A to D, 3 to 4 feet; B to C, 6 to 8 inches. (See fig. 29)

inward, one on each side, throwing the sod so as to nearly meet over the scooter furrow. This forms a catch basin for rain water and checks the growth of competing grass on each side and affords a good degree of fire protection. The appearance of such bedded or listed land is shown in Figure 29.

In the planting the trees were set 5 feet apart in furrows 10 feet apart, or 870 per acre. The purpose was to turpentine and thin out each alternate tree as soon as possible, leaving a stand of 436 trees,

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FIGURE 29.—Methods of planting slash pines: A.—A scooter-plow furrow followed by two ordinary furrows on the sides affords a very good planting ground, especially in heavy broom-sedge fields. The competition from weeds and grass is checked and the danger from fire greatly reduced. B.—Group of agricultural high-school boys planting poor sandy land on the school farm with slash pine seedlings. The trees were planted by mattocks or spades 6 by 6 feet apart, making a stand of 1,210 per acre. A good spacing on small tracts of land such as about farms

spaced 10 by 10 feet apart, for future development and working. The 10-foot lanes afforded driveways for the removal of turpentine and timber.

Advantage should be taken of favorable weather. Cloudy weather following rains affords ideal conditions. After planting no further attention is necessary, except protecting the trees at all times from fire and hogs or other injurious livestock.

No livestock should be permitted to run over land set in pines for at least the first five years. Watering and cultivating the trees in a forest plantation are both impracticable from a financial standpoint and should not be attempted. The case is different where a few trees are set out for ornamental purposes.

In a forest plantation the loss up to 15 per cent of the total number of trees set out is not an uncommon experience. Among the common causes are the poor grade of trees used, careless planting, and drought at the time of planting or soon after. If any considerable loss occurs, it is good practice to reset the blank places the next spring or a year later. The importance of fire protection is discussed below.

COST OF PLANTING PER ACRE

In estimating the cost per acre of planting pine seedlings, much depends upon the size of the operation and the kind of soil and its condition. Experience shows that some people have found it cheaper to dig wild seedlings, while many more landowners have found it much better and cheaper in the long run to plant only thrifty nursery-grown stock because of its better root development. Such trees may be grown at home, or, in most States, they may be purchased from the State forestry commission. Assuming a cost of $3 per thousand for nursery-grown seedlings, 680 seedlings per acre (a spacing of 8 by 8 feet apart) will cost $2.05. With 20 cents for furrowing and $1.25 for a third of a day with two laborers in planting the trees, the items amount to a total of $3.50 per acre, which is believed to be conservative.

With spare hands and teams in winter the farmer may be able to figure on a somewhat lower cost. Probably the planting of 1,000 seedlings per acre (5½ by 8 feet) can be done at a total cost of $5 with the possibility of lessening the cost by items of cheap labor and teams. Planting cut-over land on a large scale, one lumber concern in Louisiana has planted more than 16,000 acres of slash pines at an average cost of about $4 per acre, including all expense items. (Fig. 30.)

PROTECTION OF THE TREE CROP

Is woods burning harmful?

The damage and loss to slash pine caused by fire is enormous and ranks along with that caused by heavy and wasteful cupping. Both these causes of injury are man-made and of all the sources of injury can be most readily controlled.

The yearly burning of the woods, still practiced in some parts of the natural home of slash pine, has been done with little realization of the enormous damage to the timber and forest land and of the money loss to the owner.

If southern pinelands have seed trees and are protected from fire, young growth will generally spring up in sufficient abundance for a new crop. Young pines that are afforded protection from fire grow

rapidly and create wealth. Protection of the cut-over lands from fires (fig. 31) would mean in a relatively short time the turning of millions of acres of idle lands into profitable growing crops of turpentine and timber.

FIGURE 30.—Two hand-planted forests of slash pines. A.—A 1,000-acre hand-planted forest of slash pine in Louisiana. The trees are 5 years old and 8 to 12 feet in height. Fire has been excluded, resulting in a cover of broom-sedge grass up to 4 feet in height. The owners have planted over 16,000 acres with slash pines. B.—Five-year-old slash pines planted as year-old seedlings on an old field in south Georgia. The trees are spaced 8 feet apart, or 680 per acre. Some rough cultivation has been given to check rank weed growth

Fire protection, while very desirable throughout the life of slash pine, is particularly so during the first three to five years of the life

of seedlings. The rapid growth soon takes the sapling above the hottest fire zone, which occurs just above the dense grass. In this respect slash closely resembles loblolly pine but differs widely from

FIGURE 31.—Fire is a serious menace to young pines. A.—A fire burning at night was stopped by this woods road which is covered with carpet grass, closely grazed. All young trees on the left were killed. Across the road is a full stand of thrifty sapling slash pines. The practice is increasing of establishing carpet grass in fire breaks for grazing as a means of better protection. B.—Two furrows thrown together make a cheap and effective fire break in the wire-grass country for stopping a slow fire or for use in back-firing. A disk plow and tractor are used

longleaf pine. Although trees that have attained heights of 3 to 6 feet are injured and sometimes destroyed by slow or "cool" fires, yet

a sufficient number of trees generally remain for the growth of a fair stand. Stands of pine which have not passed through repeated fires are fortunately becoming more numerous in the South.

Fire damages and weakens mature trees, making them easy prey for insects and wood-rotting fungous diseases or so-called "punks." Trees weakened by fire are easily windthrown, and this causes the loss of large amounts of pine timber. (Fig. 15.) Millions of young pine trees, the foundation of the future forest income, are killed yearly by fire. Other millions of young saplings are defoliated and otherwise injured, resulting in stunted growth. The period of growth to reach merchantable sizes is thus lengthened and the financial returns decreased.

The leaves, or "straw," from pines contain considerable nitrogen and small amounts of phosphoric acid and potash. A ton might contain these essential fertilizing elements to the value of $2 to $4. An unburned pine woods may have as much as 10 to 15 tons of leaves and other organic matter. All this humus or woods mold has additional value as a mulch in preventing heating and drying of the soil and thus adds to the health and vigor of growth of the trees.

Pine timber grows rapidly when the trees are given enough growing space and are kept from harm by fire. (See pp. 9 and 13.)

Timber often pays all the farm taxes—grow it as a crop.

What damage is caused by insects?

Outbreaks of the southern pine beetle occur occasionally, but nearly always during years of extreme drought or locally in places where little rain has fallen for two or three months of the growing season. It is important that close watch of pine stands be kept during unusually dry periods. The adult is a small dark-brown beetle. In the soft inner bark of the tree it lays eggs which hatch into grubs, often known as "worms." These feed on the rich, living layer of inner bark and new wood, thus girdling the tree and causing its death. The life history of this insect is known, and information regarding measures for checking its depredations can be obtained from State entomologists, or from the Bureau of Entomology, United States Department of Agriculture, Washington, D. C., which has issued a publication on the subject for free distribution, Farmers' Bulletin 1586, The Southern Pine Beetle.

The pine sawyer is a large beetle whose larva, a white grub, bores into the sapwood of dead or felled timber. Its activity may be checked by peeling and drying the timber or immersing it in water.

Young slash pine seedlings are only occasionally injured by the Nantucket tip moth, which attacks the tender young shoots in the early summer. It is rare to find the shoots killed by this or any other insect. If so attacked, the tree becomes somewhat deformed, and its rate of growth is slowed up. Most trees successfully outgrow the attack.

Are pine trees subject to diseases?

If uninjured by fire or other agencies, slash pine, until an advanced age, is not seriously affected by "red heart" or other fungous diseases. Wounds caused by fire admit the spores or "seeds" of fungi, but as a rule the vigorous young trees are able to combat them successfully. Probably the antiseptic qualities of the crude

turpentine, or gum, help in this matter. After the tree reaches an advanced age red heart is likely to become an enemy, sometimes eating away the heartwood and thus weakening the tree, as well as destroying the value of the affected wood. The best protection is to keep out all fires, and cut and utilize trees as soon as they show the "bumps," which are good indications of the presence of disease.

PROFITS FROM SLASH PINE STANDS

The financial returns from second-growth pine on the farm or small holding are not difficult to determine if fire, the chief source of damage and loss, is absent. Under fire prevention or control the lands naturally restock without expense, and the timber growth is

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FIGURE 32.—Slash pine ranks as the fastest-growing pine in the South up to about 20 years of age. On old fields its growth is often extremely fast. At 13 years of age this stand is being worked for turpentine with 104 trees per acre, bringing the owner $10.40 per acre. In addition there were 524 trees per acre left for future working. This stand represents about the maximum rate of growth and yield of products for the age

rapid. A very favorable situation on many farms is that second-growth pine from 20 to 40 feet in height already occurs, sometimes covering a considerable part of the farm. If the timber is slash pine, it will be merchantable for turpentine, ties, pulpwood, and firewood at ages of from 20 to 30 years, yielding from 12 to 60 cords of wood per acre. (Fig. 32.) Older stands, from 30 to 40 years of age, yield saw timber at the rate of 7,000 to 18,000 board feet per acre. Thus slash pine affords a choice of two sources of revenue. The value of young growth is being realized more and more as utilization includes smaller and smaller sizes of timber. Under these conditions, obviously, only a comparatively few years are required for rapid-growing kinds of trees to become merchantable.

Open-grown slash pine, on average situations, may be expected to produce in 40 years a merchantable log 40 feet long, measuring 10 inches at the top by 18 inches at the butt, and containing 270 board feet of lumber.

Slash pine grows rapidly in dense stands and, at from 15 to 25 years of age, yields large amounts of crude turpentine. Concrete examples of well-stocked stands of young growth, after making liberal deductions for taxes and fire-protection costs during the period, show profits of from 8 to 12 per cent compound interest on an investment of $5 an acre.

Land of average quality in slash pine may be expected to yield continuously a net revenue from crude turpentine or gum of from 50 cents to $1.50 an acre and an equal amount from the timber growth, or a combined yearly net return of from $1 to $3 an acre.

Crude turpentine, or gum, usually sold in the standing tree, has long been looked upon in the South as a standard farm product. In many sections of the South farmers are cupping their timber and selling the gum to the local stills. After trees reach 9 to 10 inches in diameter, cupping them for turpentine is extensively practiced. For closely grown slash pine stands this size corresponds to ages between 20 to 30 years on good soils and 35 to 50 years on unfavorable situations. Open-grown trees reach this size at ages of from 15 to 25 years. Many farmers and other small timber owners have derived a good profit from selling the turpentine rights to operators of stills for 15 to 20 cents a face or cup for a period of three years' working. In 1919 the prices advanced from 15 cents a cup on average private timber to a peak price of 25 cents on timber in the Florida National Forest. When carefully turpentined for a period of from 6 to 15 years or more, including resting intervals, and then turned into rough wood products or lumber, slash pine can be handled on short rotation or at an early age with good profit.

The demand for timber to be used in making ties, poles, excelsior blocks, and stave wood indicates good markets hereafter for small-sized timber. New paper mills, each requiring from 100 to 500 cords of wood daily, are being established in the South in regions not already fully covered by similar mills. The pulpwood in many instances is drawn from locations 100 miles from the mill. Lumber of smaller and poorer grades is being used each year in increasing amounts. These factors point toward the profitable growing of crops of slash pine with resulting benefit to the landowner, the community, and the State.

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FIGURE 33.—Slash pine in its virgin haunts. In the original forest, slash pine was confined to poorly drained flat lands; but since the cutting of the virgin forests it has spread widely over much of the region formerly dominated by longleaf pine

There is plenty of land on farms for growing timber as a crop after all the better lands are used for other farm crops and for pastures.

No farmer can afford to pay taxes on idle land. Forest conservation on the farm has come to be a matter of economic necessity.

Forests, unlike many natural resources, can be used and regrown forever. Continuous production of tree crops on lands best suited for the purpose is the aim of forestry.

Since timber and wood are required for the successful operation of the farm, and since most farmers have some lands best adapted to tree growth, the growing of timber as a crop is legitimately a part of the farm program.

FURTHER INFORMATION

The State foresters at the various State capitals and the State extension foresters at the various State colleges of agriculture are in a position to furnish further information, especially regarding slash pine in their respective States. Farmers should consult their local agricultural county agents who are now dealing with forest trees as a farm crop. These agents are in close touch with the State extension forester and have for distribution various publications on the subject of tree farming. Requests may also be addressed to the Forest Service, United States Department of Agriculture, Washington, D. C., which will gladly furnish available publications or lists of publications.

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SLASH PINE is a fast-growing southern pine and yields revenue in turpentine gum at an early age while it is growing timber.

Farmers and other owners of cut-over pinelands in the South Atlantic and Gulf regions are deriving a good profit from poorly drained and other lands by utilizing them for the production of turpentine and timber as well as for the grazing of livestock.

Well-stocked stands of slash pine on average land at ages of 15 to 25 years produce wood for pulpwood, stave blocks, fuel, etc., at the rate of one-half to 1 cord an acre a year, or sawlogs at the rate of 100 to 300 board feet an acre a year. On good-quality land well-stocked stands are growing at the rate of 1 to 2 cords, or 300 to 600 board feet, per acre yearly.

Slash pine can be profitably grown in the South on poor and wet lands, but it grows better on good land.

There are millions of acres of worn-out or unimproved parts of farms and cut-over lands that are profitless for other crops, but suitable for the production of timber and naval stores.

By proper methods of protection and cutting, southern pine forests can be perpetually renewed and kept continuously productive.

Young pine is valuable.

The picture on the title page shows second-growth slash pine in southern Georgia being worked for turpentine.

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SLASH PINE

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SLASH PINE—A DUAL-CROP TREE

SLASH PINE, a native of the South Atlantic and the Gulf region, is one of the most profitable forest trees in the United States.[1] In its own range it is being extensively cared for and planted in orchards because of its rapid growth and high value for the production of naval stores, pulpwood, and lumber.

Second-growth slash pine, following the cutting of the original forest, has spread rapidly over large areas of flatlands and low uplands of the region. It has been particularly aggressive in establishing itself on old fields and other idle or waste lands about farms and towns. A large percentage of the total amount of sap pine cut for all purposes in southern Georgia and northern Florida is slash pine. Timber from original-growth trees is used or sold without discrimination along with longleaf pine.

The wood of slash pine is straight-grained and suitable for a wide variety of uses. The width of the rings naturally depends on the rate of growth. The yield of crude turpentine from slash pine is the largest from any of our native trees. In the economic development now well under way in the South, slash pine is playing a large part in bringing lands not suited for other agricultural crops into their most profitable use.

A caution in managing slash pine lands cannot be too strongly emphasized. The custom of turpentining small trees before they reach the age of profitable working and ample seed production calls for special attention in management. There should in all cases be an

[1] The botanical name is *Pinus caribaea* Morelet. Formerly in forestry literature the tree was called Cuban pine.

> The right use of the turpentine hack and later the ax and saw, and the protection of the land at all times from fire are the keys to the problem of growing slash pine profitably as a crop.

abundance of seed just before making the final cutting of the timber crop so as to provide for the renewal of the stand as the necessary basis for another timber crop on the land.

How can you tell slash from other pines?

Because of the general resemblance of young slash pine to vigorous loblolly pine, and of the mature slash pine to longleaf pine, considerable difficulty is experienced by persons unfamiliar with the southern pine forest in differentiating the species. However, slash pine is not difficult to identify if one possesses the essential information regarding the leaves, cones (burs), bark, and winter bud.

The bark (fig. 1) is fairly similar to that of longleaf pine. It differs from that of loblolly pine by being less deeply furrowed. Old mature slash pine may be readily told by its orange-colored bark plates or scales.

The leaves grow in clusters of two or three, usually with more of the two-leaved clusters. They are mostly 8 to 12 inches long, and bright, glossy rich green (fig. 2). The heavy, shiny green foliage helps greatly in distinguishing slash pine from the associated longleaf pine with its coarser and rather bluish-green foliage. Loblolly pine, like longleaf pine, has three bluish-green leaves in a cluster, but it has much smaller leaves than long leaf or slash.

The cones are egg shaped and average 3 to 4 inches in length and, when closed, are about 2 inches wide (fig. 2). A prickle is borne on the lustrous or varnished brown end of the cone scale.

The terminal bud is large, is reddish brown in color, and in the spring elongates into a straight, stout, light-gray "candle" about as thick as a large pencil. Longleaf pine, in distinction, has a similar but larger bud elongating into a light-gray candle an inch or more in diameter.

The main characteristics by which slash pine may be identified are the two-leaf or three-leaf clusters of long, dark-green leaves; the slender prickle on the cone, pointing straight or slightly curved upward on the lustrous-brown scale of the fresh mature cone; and the early-spring candle or shoot, which is light gray, erect, and about one-half inch in diameter.[2]

Mature trees of slash pine rise to heights of 80 to 125 feet, with clear lengths of 40 to 70 feet. Diameters of trunks range from 2 to 3 feet, measured at breast height, or 4½ feet from the ground.[3] Old-growth trees at maturity are mostly from 100 to 200 years old.

WHERE SLASH PINE GROWS

The natural range of slash pine extends from about Charleston, S. C., westward through the lower parts of Georgia, Alabama, Mississippi, and southeastern Louisiana to the Mississippi River (fig. 3) There are large areas of slash in Georgia and in Florida, where the tree grows nearly to the end of the peninsula. Slash pine is commercially important over its whole range.

In the original forest slash pine was confined mostly to the poorly drained flatlands and borders of swamps and bodies of fresh water. With the subsequent extensive cutting slash pine was released in much

[2] The spring shoot of loblolly is grayish green, slender, and often curved or drooping instead of erect.

[3] Unless otherwise stated, all diameters referred to throughout this bulletin are based on measurements at breast height.

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FIGURE 1.—A young generation of slash trees about 14 years old is shown with a mature tree. Light orange-colored scales or plates of bark serve to distinguish mature slash pines from other species of pines.

the same way as was loblolly pine farther north, and it is now spreading widely over lands formerly dominated by longleaf pine (fig. 4). It is found on many different kinds of land, but not on dry, deep sandy ridges. On wire grass and palmetto flats it is often the only second-growth species of pine. Slash pine thrives extensively over the low, rolling lands of the southern Coastal Plain, in sandy loam soils in poorly drained situations, and in the wet, mucky soils of bays,

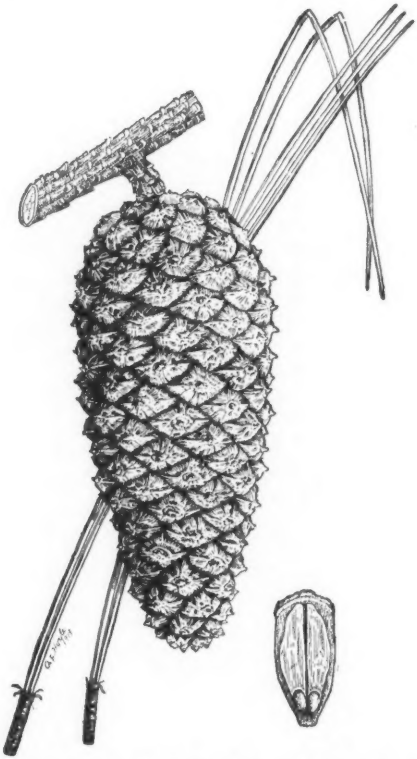

FIGURE 2.—The cone or bur of slash pine is 3 to 4 inches long. The ends of the cone scales are plump, rounded, lustrous, and bear a small prickle. At the base of each scale are borne two seeds, each with an ample wing for wide dispersal. Leaf bundles of slash pine contain either two or three leaves.

ponds, and swamps. It will tolerate a highly acid condition in the surface soil, and a calcareous substratum does not appear to be unfavorable to its growth. On soils with hardpan at shallow depths the tree appears to be somewhat dwarfed in size. It is absent from the very dry, deep sands of the "pine-barren" hills, such as are found in parts of western Florida and southern Mississippi; but even in those sections it is locally abundant on wet flats and close to lakes and streams and in the numerous ponds scattered all over the Coastal Plain. By means of planting the range of slash pine is being considerably extended.

THE WOOD AND ITS USES

Slash pine averages the heaviest, hardest strongest of all the commercial conifer woods in the United States.[4] The weight of the air-

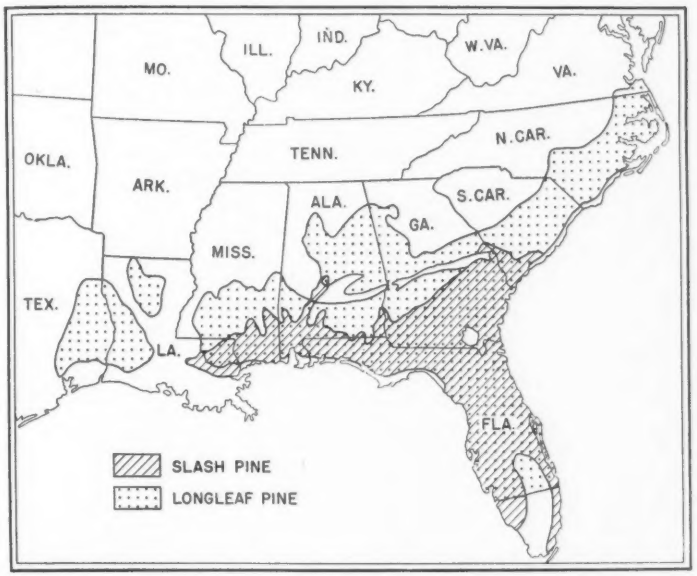

FIGURE 3.—Slash pine is found growing naturally in the region shaded by lines. Longleaf pine is found in the region indicated by scattered dots. Both kinds of pine thus occur in the slash pine belt.

dry heartwood averages 45 pounds per cubic foot. In the butt cut the wood averages about 55 percent of dense bands of summerwood, while farther up the tree the proportion of summerwood decreases, at the top of the second cut to about 40 percent (fig. 5).

What are the chief uses of the wood?

The lumber from mature slash pine is used for structural purposes and is in demand for bridges, trestles, docks, warehouses, and factories, in which it is employed for dimension timbers, posts, piles, and joists. On account of its strength and stiffness, it is used for railroad cars, and its hardness and wearing qualities make it suitable for flooring. It is extensively used for veneers for boxes and other packages, and as boards for slash cooperage.

Second-growth or "sap" slash pines after being turpentined are extensively cut for use as cross ties and pulpwood.

The wood of slash pine is well adapted for making paper pulp, and the mills accept it (fig. 6) readily along with that of other kinds of pine. The wood is manufactured into kraft paper, which is the extensively used brown wrapping paper made in various thicknesses

[4] According to results of tests made at the Forest Products Laboratory, U. S. Forest Service, the wood of slash pine averages a little heavier, harder, and stronger than that of longleaf. Dept. of Agr. Tech. Bull. No. 479, Strength and Related Properties of Woods Grown in the United States.

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FIGURE 4.—Thrifty slash pine trees 22 years old. One group of the smaller trees has been worked for turpentine and cut out, leaving the larger trees to grow for other crops of turpentine and poles, piling, or saw timber.

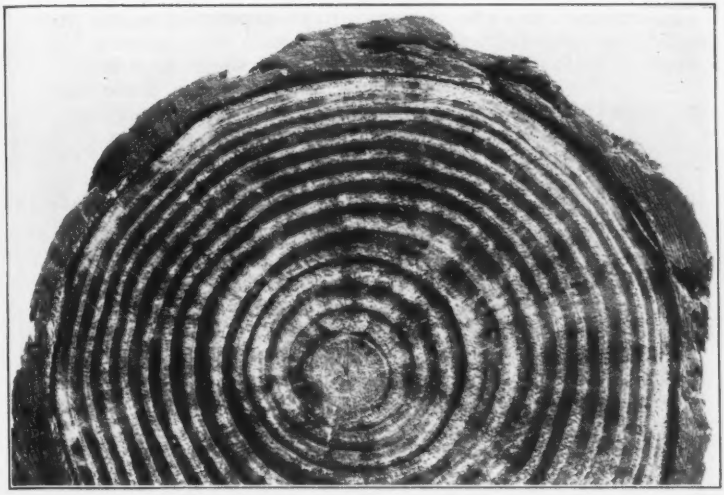

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FIGURE 5.—The very dense or heavy wood of the slash pine, formed even during its early years, is a good characteristic of the tree. The 17-year-old tree shown in the section produced 63 percent dense summerwood, leaving only 37 percent soft springwood.

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FIGURE 6.—The use of southern pine for pulpwood is rapidly increasing. The pulp mills buy round or split wood from 4 to 12 inches in diameter. There is a much larger demand than formerly for slash and other pines for making paper.

and shades of color. The paper industry is expanding rapidly throughout the pine region of the South. Analysis has shown a low percentage of resin in sapwood of cut trees. Slash pine is also used extensively for fuel. Because slash pine occurs in dense stands of straight clean trees, it is one of the choicest timbers for poles and piling, for which use it is cut in large quantity and brings good prices (fig. 7).

GROWTH OF TREES

Slash pine is one of the most rapid growing and earliest maturing of all our forest trees. Growth in height and in diameter is especially rapid during the younger stages up to about 20 years of age. One-year-old seedlings commonly reach 8 to 12 inches in height.

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FIGURE 7.—Slash pine trees grow in close or dense stands and after turpentining are cut in great numbers for telephone and power-line poles. Treated with creosote they will last for 20 to 40 years.

At 5 years, slash pines range mostly from 8 to 12 feet in height. During the next 5 to 10 years an upward growth of 2 to 3 feet yearly is not uncommon. When about 20 to 25 years of age the rate of upward growth slackens, apparently being about the same as that of longleaf on situations of similar grade. In crowded stands (fig. 8) the increase in diameter is slower than that of trees growing a considerable distance apart. Table 1 shows for different ages the average heights and diameters of slash pine trees and the number of trees per acre found in well-stocked stands. The range in size at any given age varies chiefly with the favorableness of the soil or situation and with the tree density, or number of trees per unit area.

How fast do slash pine trees grow?

For example, as shown in table 1,[5] at 15 years of age the trees in well-spaced stands range in height from 29 up to 48 feet, and in open-grown stands (columns 5, 6, and 7) in diameter from about 5 to more

[5] The tables of growth, volume, and yield of timber and much of the information on good turpentine practices are based upon the results of studies carried on by the Southern Forest Experiment Station of the Forest Service, located at New Orleans, La.

than 8½ inches. If, however, the trees have grown closely with less space for development, it is not uncommon to find them from about 4 to 6½ inches in diameter at breast height, as shown in columns 8, 9,

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FIGURE 8.—The adaptability of slash pine to heavy wet soils enables it to grow rapidly even in dense stands, thus producing a large amount of wood in a relatively short period. This stand should now be thinned for wood products and worked conservatively for turpentine. The latter operation can be continued for 20 to 30 years.

and 10. At 30 years slash pine stands usually consist of trees ranging from 48 to 79 feet in height, and in diameter in open stands from 8 to 13½ inches, or in crowded stands from 6 to 10½ inches. Crowded stands 30 years old may have about 300 trees per acre that measure 7 inches and more in diameter. Open, or better spaced stands for turpentining may have from 150 to 200 trees per acre.

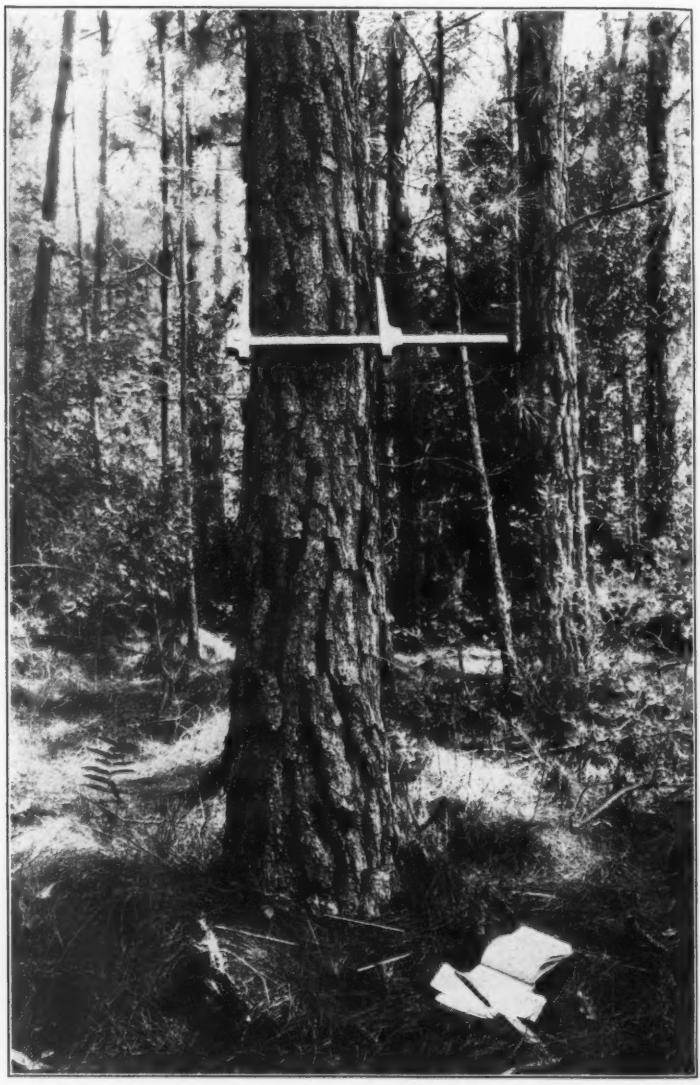

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FIGURE 9.—Example of fastest growth of slash pine resulting from continuous fire protection. The trees in this 17-year-old unburned stand were mostly from 8 to 13 inches in diameter and from 50 to 65 feet tall. The average tree was 10.7 inches in diameter (breast height) and 61 feet tall. In the 17 years this open-grown stand had produced 12,600 board feet of lumber. The thick mat of pine leaves or straw, plainly seen in the picture, affords favorable soil protection against extremes of heat and drought.

TABLE 1.—*Average size of slash pine trees at different ages grown in open and in close stands on different grades of soil; also average number of trees per acre*

Age of trees (years)	Height of trees on—			Diameter of trees (breast height)						Trees per acre in fully stocked timber stands [1]
				Open-grown stands on—			Close-grown stands on—			
	Good land	Average land	Poor land	Good land	Average land	Poor land	Good land	Average land	Poor land	
	Feet	*Feet*	*Feet*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Number*
15	48	39	29	8.8	6.9	5.2	6.6	5.2	3.9	55
20	61	48	36	10.3	8.0	5.9	7.7	6.0	4.4	150
25	71	56	42	12.3	9.6	7.1	9.2	7.2	5.3	265
30	79	63	48	13.7	10.8	7.9	10.5	8.3	6.1	360
35	86	69	52	15.2	12.0	9.0	11.7	9.2	6.9	365
40	92	73	55	16.6	13.1	9.9	12.8	10.1	7.6	325
45	96	77	58	17.1	13.5	10.1	13.7	10.8	8.1	280
50	100	80	60	18.1	14.2	10.7	14.5	11.4	8.6	260
55	103	83	62	18.8	14.8	11.0	15.0	11.8	9.0	245
60	106	85	64	19.4	15.2	11.6	15.5	12.2	9.3	230

[1] All trees 7 inches and over in diameter outside bark at breast height. The trees on the better qualities of land are fewer and larger in diameter; the number on the poorer lands is greater and the trees are smaller in diameter.

The sizes of trees growing in good grade of soil are shown in the columns headed "Good land." The class "Poor land" includes very wet or highly acid soils, on which, however, slash pines often seed freely, but the trees make only slow growth and reach relatively small sizes at maturity. The "Average land" class applies to the great bulk of lands on which slash pine is found growing.

An open stand growing in an old field in northeast Florida is shown in figure 9, where the average tree of the 17-year-old stand was nearly 11 inches in diameter and 61 feet tall. Fire protection had been afforded throughout the life of the stand, which undoubtedly accounts for the large size and thriftiness of the trees and the maximum timber yield of the stand. Such open-grown or orchard-like stands favor the early production of turpentine and merchantable sawlogs, but sacrifice a larger production per acre at a later date. However, moderately open-grown stands should be favored over too-dense stands.

Do tree trunks lengthen?

Yes, but only by new growth at the top. Once the side limbs are formed, or set, they remain in that same position throughout the life of the tree, or until they die and drop off. All limbs or branches from the main trunk reach to the heart or center of the tree.

THINNING PINE STANDS

What effect does thinning have upon growth?

As in a stand of corn or cotton, the trees in a full pine stand crowd upon each other, and the stronger trees gradually crowd out the weaker. Too few trees on an acre result in bushy tops and knotty lumber; too many trees mean a slowing up of individual growth. There is a right number, varying with the age and location, to obtain the best growth of the largest number of trees. Thinnings are made when it is necessary to reduce the number of trees so as to obtain the maximum growth for the kind of product desired.

How should thinnings be made?

There are two ways of thinning pine stands. The whole subject of thinning slash pine stands is closely related to the working of trees for turpentine.

A so-called low thinning, as shown graphically in figure 10, consists of cutting out the smaller, less vigorous, diseased, and unpromising trees. They may be worked first, but only if profitable. This method favors the largest and best trees and more nearly keeps the timber production at its capacity. Size and quality count much in the value of the timber.

A well-known principle is to wait until the trees to be removed have reached a usable size, so that the thinning may at least pay for itself. The material removed may be used for firewood, pulpwood, excelsior wood, or small saw timber. However, in actual practice with relatively cheap labor during slack periods, it is often good practice to thin overcrowded young pines before they reach usable size. An idea of the number of trees per acre in full timber stands at different ages can be obtained from the last column of table 1. For best production of turpentine these numbers should be reduced one-half to two-thirds. Closely related to this subject is the plan of thinning and turpentining found on page 24, which should be considered along with this discussion (fig. 11).

In a so-called high thinning, the larger trees are worked and cut, thus giving space for the smaller trees to expand. It is not an uncommon practice of owners to work and cut the largest trees, because they are the first to become merchantable. What happens then is that the formerly stunted trees recover and attain normal growth. This adjustment usually requires a number of years, during which there is a loss in the growing power of the land. Thinning by this method (of cutting out the largest trees) permits of a periodical money return every 5 years or so, a feature which appeals strongly to the farmer or other owner of timberland and is especially desirable when adapted to cutting timber, without turpentining it, for pulpwood, fuel wood, or other small-sized product.

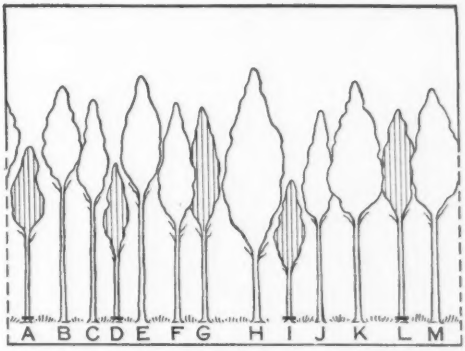
Pruning side branches makes clear trunks, desirable for turpentining and later for poles, piling, and saw timber. It may be started relatively early when the trees are 12 to 15 feet high. A good rule for young trees is to prune the lower half of the trunk and later the lower two-thirds. Too heavy pruning checks the tree's growth. Branches should be cut close to the main trunk in order not to leave a stub and even slightly wound the living layer (cambium) lying between the inner bark and the last layer of wood (fig. 11, *A*). An ordinary curved pruning saw has proved a good tool to use. A short ladder to reach the higher branches is also desirable.

TURPENTINING SLASH PINE

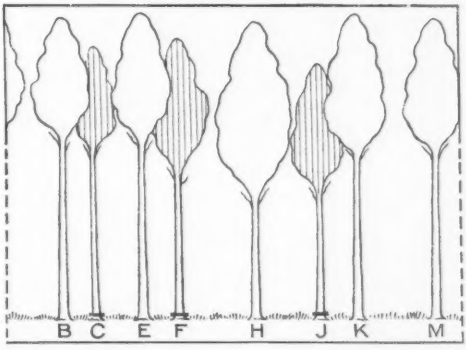
The growing of slash pine as a farm crop or, on a larger scale, as an agricultural industry centers largely about its capacity for producing naval stores as well as sap pine wood.

For every dollar of profit made from the wood of slash pine there is likely to be a return of not less than $2 from the crude gum (oleoresin). A too-common practice has been to work the trees as soon as they reached diameters from 6 to 8 inches, and after 3 to 4 years of working

Thinning.—Age of the trees, 5 to 10 years. A light thinning is to be made by cutting out the smaller, slower-growing trees, *A*, *D*, *G*, *I*, and *L*. This will still keep the bigger trees slightly crowded to force them to grow upward instead of growing outward and becoming bushy.



Thinning.—Age of trees, 15 to 20 years. Another thinning is to be made now of the smaller, less vigorous and less promising trees, *C*, *F*, and *J*.



Final cutting.—Age 30 to 40 years. The final cutting is made of all trees except one, *H*, a vigorous, bushy-topped tree, which is left to produce seed and restock the land. About three such trees are left growing on each acre until the land is well reset with young trees.

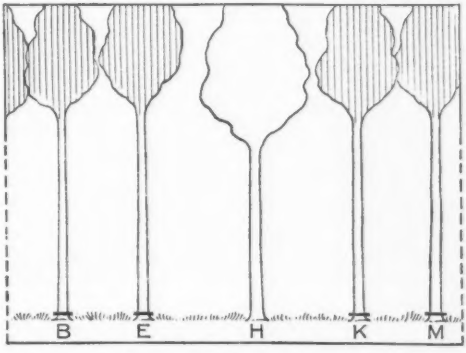


FIGURE 10.—A good method of working, thinning, and later cutting the final crop of pine trees where turpentine and timber products are desired at intervals. The smaller, less vigorous, and defective trees of this even-aged stand are worked and cut out, giving space for the stronger-growing trees to grow. This is repeated a few years later. The cuttings produce fuel wood, cross ties, small sawlogs, or pulpwood. The final cut produces saw timber or piling of good size, grade, and value. The trees to be cut are shaded. The letters aid in identifying the trees.

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FIGURE 11.—Thinning and pruning young slash pine are desirable practices, favoring better growth and higher quality and value: *A*, This farmer (on right) during slack time in one winter thinned and pruned 86 acres of dense sapling slash pines. Stands of 900 to 2,000 saplings per acre were cut down to 150 to 300 trees. Both the pruning and thinning were somewhat too heavy, reducing the amount of growth. *B*, A very thrifty planted stand of slash pine 9 years old that should already have had two light prunings. The growth would not have been reduced, and the value of the stand would have been markedly increased.

to abandon the stand. Usually the trees have soon been greatly injured by fire, and in this manner second-growth trees have been extensively destroyed.

With the increase in the value of pine, practices of turpentining are improving. However, much pine timber is still being worked too small and too young, and the chipping is generally too deep and too wide up the tree. In order to keep pace with the keen competition that exists in the naval stores industry the successful turpentine man needs to use methods that will give him the greatest possible gum yields, keep down the costs, and maintain the vigor of his trees.

What are gum and naval stores?

When the sapwood of pine trees is wounded or chipped, it bleeds a thick sticky liquid known as crude gum (oleoresin). The gum is not, as is often supposed, the sap of the tree. It is not drained from a store in the tree but is formed in small cells or ducts scattered in the sapwood. When the tree is cut or wounded, these increase greatly in activity in order to heal over the wound. The heartwood is dead and, if cut, does not produce gum although it contains considerable hard resin.

It is well known in the South that this gum when heated in a still gives off a volatile liquid called spirits of turpentine, leaving a heavier thick residue which, upon cooling, solidifies to form rosin. In the days of wooden ships, turpentine and rosin and other products, known as naval stores, were made and extensively used in calking and waterproofing the hulls as well as in tarring the ropes.

How does slash pine rank in gum production?

Slash pine excels all other native pines in the quantity of gum which flows from the trees when chipped.

Its gum, when freshly exuded, is clear and about the color of light-yellow honey. As compared with longleaf or "hill" yellow pine, its nearest competitor, slash pine yields from its dip and scrape combined a slightly higher percentage of spirits of turpentine and a higher grade of rosin. In contrast to longleaf it produces only a little scrape. It is not uncommon to hear it said that slash pine is more likely to "dry face" and die from turpentining than is its associate, longleaf pine.

What are some good practices in turpentining?

Practices that are generally recognized to be advisable as a means of getting the most revenue out of timber, consistent with conditions of labor and market, include the following:

(1) Work no trees under 9 inches in diameter (at breast height measured outside the bark). Trees to be removed in thinning or improvement cutting may be considered as exceptions to this rule. The size of such trees that can be worked at a profit depends on the vigor or rate of growth and the density of the trees.

Only small yields, with rarely any profit, are obtained from trees less than 9 inches in diameter. Beginning with a 9-inch tree and working one low face at a time insures a high, sustained yield over a period of years and the largest profit in the long run to both owner and operator (fig. 12).

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Undersized trees in planted stands can often be worked profitably previous to thinning.

(2) Work only one face on trees from 9 to 14 inches in diameter, and never more than two faces at the same time on any tree.

(3) Advance streaks should be made preferably 4 to 6 weeks ahead of the regular chipping season.

(4) Use rust-free cups and gutters. Aprons or gutters should be attached with large-headed rustproof tacks, or they should be inserted in very light ax cuts. Do not slab off unnecessary amounts of bark and wood at the base of the tree. Careful hanging of cups and aprons or gutters prevents waste of gum.

(5) Use a No. 0 hack, as this permits cutting streaks one-half inch up the tree and three-fourths inch deep; this is known as medium-

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FIGURE 12.—Good turpentining is shown. Only the larger trees, 10 inches in diameter or over, are being worked, with only one face per tree, and in 2 years the faces are only 32 inches in height. The cups were raised for the second year's working.

light chipping. Conservative methods of turpentining give a longer working life to the trees than heavy workings, which cause dry face and destroy more timber.

Low chipping, faces one-fourth to one-half inch in width, gives more gum than high (three-fourths inch) chipping over the lifetime of the tree. However, chipping one-half inch in height is best if the face is to be worked for 2 to 4 years or more. Low chipping is adapted for owners wishing to operate their timber continuously over a long period of years.

In practice depth of chipping ranges mostly from one-fourth to three-fourths of an inch (fig. 13). The yield of gum at the time increases considerably with an increase in the depth of chipping. Fast-growing slash pine can be chipped three-fourths of an inch deep for 4 or 5 years. Deep chipping in slow-growing timber results in exces-

sive dry face. Also deep chipping weakens the tree mechanically, making it more likely to be windthrown.

(6) Hang the cups as low as possible when the trees are first worked to prolong the working life of faces.

(7) Chip not more than one-third the circumference of the tree for a single face.

(8) Leave at least 4 inches of living wood for bars between the faces on all trees.

FIGURE 13.—Cupping trees for gum: *A*, Chipping a streak on a face is good turpentining practice. The cup is hung low, the tins are inserted lightly, and the streaks are shallow. *B*, Veteran slash pine tree which has been worked for more than a quarter century, first by the old boxing method on the front and the back faces. These have nearly grown over, and now active turpentining is under way on the new wood.

(9) If the crop is not well protected from fire, following the season's working, rake the ground clean for a distance of 2½ feet on all sides from the base of each worked tree (fig. 14).

More and more working is being done under fire protection on rough land. This eliminates the expense of raking and burning.

What are some bad turpentining practices?

Unprofitable practices of working timber include: (1) Working too small trees (figs. 15 and 16), (2) chipping too deeply and too wide, (3) placing too many faces on trees, and (4) leaving insufficient width in bars between faces.

It is difficult for private owners and operators to break away from the custom of cupping very small trees and over cupping large ones. In their desire for immediate returns they sacrifice heavily in income, or "kill the goose that lays the golden egg." A case is known in which

slash pine trees were cupped when 8 years old and the same trees backcupped 7 years later. Frequently all trees are cupped down to 6 or 7 inches in diameter, 2 cups hung on trees down to 9 or 10 inches, and 3 cups hung on trees 13 inches and over by laborers who are paid on the basis of each 1,000 cups hung, or of each crop of 10,000 cups. Heavy working is wasteful practice, except for the purpose of clearing up land or thinning heavy stands.

The flow of gum appears to be generally in proportion to the size and vigor of the trees and the size of the face up to the point where the tree is faced too severely. Practical men in the turpentine industry repeatedly express the opinion that a large percentage of the smaller-sized trees now bled are too small to pay for the cost of operation. The almost complete loss by wind and fire of small trees during or after severe turpentine operations is another important economic reason for adopting conservative methods.

F210492

FIGURE 14.—If the crop is in much danger of burning, at the close of the season each tree is raked in order to give protection. Unburned land makes thriftier trees which yield more gum. Many operators are beginning to work their trees in rough, or unburned land.

YIELD OF GUM

How much gum and naval stores will a slash pine tree yield?

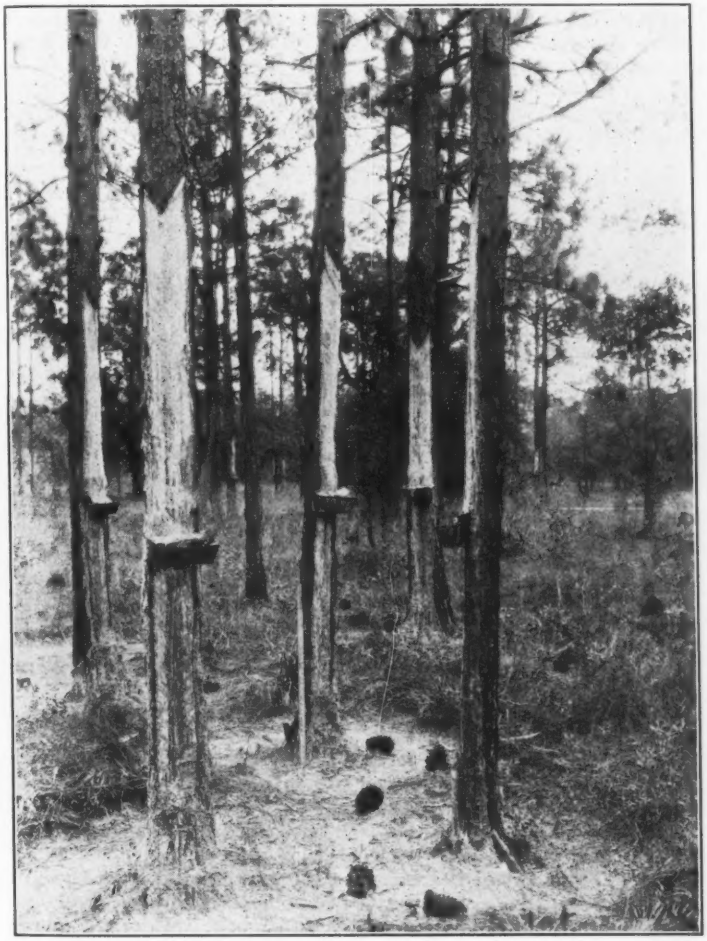
A slash pine tree, growing in an open stand worked with 32 streaks during the season and scraped, will yield as follows: If 9 inches in diameter (breast height), about 123 ounces; 10 inches, about 140 ounces; and 12 inches, about 180 ounces. Compare with these figures the yields of trees smaller than 9 inches, namely, 95 ounces from 8-inch trees and 80 ounces from 7-inch trees. In crowded or dense stands small trees run about one-quarter less for 9-inch trees and one-half less for 7-inch trees.

In units of naval stores the yield of slash pine trees may be illustrated by the average 9-inch tree, which produces a little under 8 pounds (123 ounces) of gum, which will make about one-fifth of a gallon of spirits of turpentine and about 5 pounds of rosin. A 12-inch tree will yield 11.2 pounds of gum, which will make about one-third of a gallon of spirits of turpentine and about 7 pounds of rosin.

How much naval stores will a crop of slash pine yield in a season?

There are 10,000 cups in a crop. Varying widely with conditions of size and vigor of trees, as well as the locality and the season, a crop of cups will yield in a full season from 100 to 400 barrels of gum. One dip barrel (50 gallons) of gum commonly yields from 10 to 11 gallons of spirits of turpentine; or it requires nearly 5 barrels of gum

to produce 1 barrel (50 gallons) of spirits of turpentine. The size of the tree is an important factor. A crop of average open-grown trees, worked for 5 years with 32 streaks per year, chipped one-half inch



F225685

FIGURE 15.—Bad turpentining is shown. All the trees, including those of all diameters down to 5 inches, are being worked. The faces are deep, and the aprons have been driven deep into the trees. This causes low production of gum and heavy losses of timber.

deep by one-half inch high, with one face per tree should yield about as follows for different-sized trees: A crop of 9-inch trees should produce about 42 barrels of spirits of turpentine; 10-inch trees, 49 barrels; 11-inch trees, 55 barrels; and 12-inch trees, 62 barrels. With these trees of regulation sizes, may be compared the amounts of

naval stores yielded by crops of undersized trees; namely, 8-inch trees averaging 36 barrels and 7-inch trees averaging only 31 barrels.

The amount of rosin produced at the same time is about 3⅓ barrels to 1 barrel of spirits of turpentine. For example, a 50-barrel yield of turpentine at the ratio of 1 to 3⅓ means a production of about 167 barrels of rosin. The foregoing indicates the reason why working small trees does not pay expenses.

Trees grown in dense stands yield about one-quarter less gum for 9-inch trees, one-sixth less for 12-inch, and one-third less for 7-inch trees.

F230217

FIGURE 16.—Deep chipping and the inserting of aprons often result in serious loss of timber and money returns. Such loss as this by wind and also dry facing are, fortunately, less common now than in the past.

What are some important factors about turpentining and naval stores?

A barrel or cask of spirits of turpentine contains 50 gallons. A gallon weighs about 7¼ pounds.

A barrel of rosin weighs about 500 pounds gross but contains about 420 pounds net of rosin.

About 20 percent of the weight of the gum or dip from the cups is spirits of turpentine. An average of about 9 percent by weight of the scrape is spirits of turpentine, although there is a wide variation.

The scrape from slash pine trees is relatively small in amount. It is about 6 percent by weight of the total gum yield of the tree (dip and scrape). In contrast, the scrape from longleaf pine trees, if the cups are raised each year after the first, comprises about 24 percent of their total product. Otherwise the scrape is relatively larger in amount.

About 40 pounds of dip is required to yield 1 gallon of spirits of turpentine, or about 5 barrels of dip (400 pounds of dip per barrel) to yield 1 barrel of spirits of turpentine. For each barrel of spirits there is produced on an average for the season's run about 3⅓ barrels of rosin.

Advanced streaks are of much value in producing larger yields of gum during the early chipping season. The time recommended to make advance streaks is 4 to 6 weeks ahead of the first regular streak.

Low chipping (that which removes from one-quarter to one-half inch in height by each streak) for a season or two may result in less gum, but if it is continued for the entire working life of the face it will result in a larger yield of gum than high chipping. Medium chipping of about one-half to three-quarters of an inch in depth gives the best results in slash pine (fig. 17). Deeper chipping, although for a time giving a higher gum yield, results in greater injury by dry face and by windfall.

FIGURE 17.—A stand of slash pine that is being progressively worked. The larger trees that have been worked with one face for 5 years have just been back-cupped. The small worked-out trees have been cut into pulpwood or fuel wood.

The flow of gum depends closely upon the weather. A hot spell and likewise a hot, rather dry season will increase the flow of gum.

The larger the tree the larger the total yield of gum, other conditions being practically alike. Trees measuring under 9 inches in diameter (at 4½ feet above the ground) are doubtful money makers.

The largest total production of gum from a tree is obtained by working only one face at a time, chipping low and moderately deep, and nailing instead of driving the tins. Deep driving of the tins weakens the tree, causes more windthrows, increases dry face, invites insect attack, and decreases gum yields. When two faces are worked at the same time on trees up to 12 inches in diameter the total yield is only about 70 percent as much as that obtained by working only one face at a time. Experiments indicate that not more than one face should be currently worked on any tree which is less than 14 inches in diameter.

On the national forests in Florida turpentining rights have been leased for many years to individuals or companies under the terms of a carefully drawn contract sale. This also is being started on some of the more recently created national forests in the South. Sample copies of the form used will be mailed upon application to the regional forester, United States Forest Service, Atlanta, Ga.

The Department of Agriculture has a number of publications dealing in detail with various phases of turpentining. Application should be made to the Office of Information, United States Department of Agriculture Washington, D. C.

EFFECTS OF TURPENTINING AND FIRE

Does turpentining affect the growth of a tree?

The rate of growth is greatly checked by heavy cupping. One face per tree generally checks the growth of slash pine from one-fourth to one-third of the usual rate; two or more faces, one-half or more. Following the working of the tree, a gradual recovery in rate of growth and a natural healing over of the face take place, faster in the more vigorous and healthy topped trees.

Along with the injury from wounding and attendant loss of gum, it appears certain that exposure to uncontrolled fires and the injurious agencies of rot and insect infestation subsequent to turpentining have much to do with any decline in growth that may occur. It follows that slash pine, if properly handled, may be turpentined to advantage in advance of the final working and harvesting of lumber.

Does burning affect the yield of gum?

Since the yield of gum depends much upon the vigor of the tree, full protection against heavy burning is very profitable. The burning off of the leaves or needles or straw results in reduction of gum flow until they have grown back fully (fig. 18). By killing living limbs fire causes a continuous reduction in the gum yield. Burning off most of the foliage on young timber being worked for gum is known to have reduced the yield to one-half that on adjacent unburned trees. (See also p. 46.)

TURPENTINE MANAGEMENT PLAN

In simple terms, the problem of managing a stand of slash pine has as its main object obtaining the largest amount of gum and then cutting the trees for pulpwood, lumber, or other product; pine wood is coming to have an increasing use and value for pulpwood (fig. 19).

What are the important steps in handling slash pine as a dual crop?

A stand of young slash pines may be regarded as safe from ordinary ground fires when the trees are from 10 to 20 feet in height. Such trees will be from 6 to 12 years old. At this stage the stand may be thinned out so as to save from 200 to 300 per acre of the best trees, evenly spaced.

When the trees have reached heights of 50 to 60 feet, with diameters ranging from 9 to 10 inches, turpentining operations may be begun on all the trees except about 100 of the best-developed and thriftiest trees left as evenly spaced as possible to form the final timber crop. The trees may be worked for 3 years, rested a year, and back-cupped for the next 3 years—making a work period of 7

F254975

FIGURE 18.—Fire reduces the ability of the tree to produce gum. If the tops or leaves are burned off it is advisable to rest the tree for at least 1 year. Badly burned trees may not recover for several years.

F247935

FIGURE 19.—Chipping and dipping crude gum in a stand of slash pine.

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years (fig. 20). The worked trees may then be cut and utilized for one product or another. The age of the remaining 100 trees will be from 25 to 40 years.

Slash pine trees or stands, when protected and rightly handled with rest period, can be worked for turpentine from the ages of about 15 to 40 years, or longer. A well-stocked stand will average a growth of 1 to 2 cords of wood per acre per year during the period of from 10 to 40 years, or an equivalent of 300 to 800 board feet per acre yearly.

This brings the owner to the last stage of management with an option of two courses, either of which may be adopted. The trees may all be worked as they grow, conservatively, one face at a time, for a period of 6 to 20 years. If the alternative method is adopted, the trees are allowed to grow to a good size for lumber, say 15 to 18

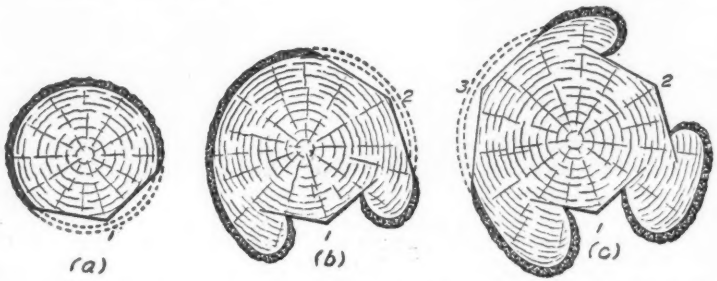


FIGURE 20.—The first working was begun when the tree (*a*) reached 10 inches in diameter (breast height). The second (*b*) was begun after a 3-year working and 3 years of rest; and the third (*c*) after similar periods of working and rest. Thus, the tree was worked 9 years during a period of 15 years. This method is one of very conservative working, resulting in a good growth of timber and high yield of gum. (The figures 1, 2, and 3 serve to identify the three faces).

inches, when they are worked heavily with two or more faces per tree for 3 or 7 years; in the latter case a year's rest is included. If the market is good, one or two high workings may be added.

The time required to grow the crop or the rotation period as here outlined will vary from 35 to 50 years, depending mostly upon the conditions of growth and market for naval stores and timber.

The exclusion of fire during the life of the stand and the one or more openings of the stand due to cutting the worked trees should result in a good restocking of the land to young pines. In the event, however, of failure to have a sufficient stand of young growth at the time for the final cutting of the mature tree crop, it would be necessary to make some special provision. One good way would be to arrange for the cutting during the late fall or winter following the scattering of a full crop of seed or mast.

LEASING TIMBER FOR TURPENTINE

The right to work trees for turpentine, often called a lease, is sold by timber owners to operators. The time is generally from 3 to 5 years, and the prices vary, depending upon the market and the size and location of the trees. Prices generally run from 3 to 5 cents per face per year, which for a 4-year lease would range from 12 to

20 cents per face. If the timber is leased on a percentage basis, the operator usually pays the timber owner from 15 to 25 percent of the local value of the turpentine and rosin produced.

Turpentine Leasing Agreement for Farmers

In leasing out turpentine rights to timber it will pay the owner well to do it under a written and signed agreement. Such a contract, in fact, will safeguard the interests of both parties. The essentials of such an agreement, as embodied in the following sample lease applicable to the use of small owners, are based upon one used by the United States Forest Service in leasing its timber on the national forests. Such money items as the rental charge per face and others which vary locally and from year to year are inserted here merely as illustrations to make the form as clear as possible.

Naval Stores Agreement

I, John Doe, of Pine City, State of Florida, hereby agree to work for naval stores certain timber on the lands owned by Richard Roe, Leesville, Fla. Said timber is all the slash and longleaf pine timber not excepted under the terms of this agreement located on an area of about 40 acres to be definitely designated by Richard Roe before cupping begins in section 9, township 4 north, range 6 east, Tallahassee meridian and base line, upon which it is estimated that 2,000 cups, more or less, may be placed. In consideration of the granting of this privilege to me for a term of 4 years I do hereby promise to pay to Richard Roe the sum of $400, more or less, as may be determined by actual count, at the rate of $200 per thousand cups, payable on or before March 15, 1939.

And I further promise and agree to work said timber in strict accordance with the following conditions:

(1) No tree will be cupped, chipped, raked, or worked in any manner until payment has been made in accordance with the terms of this agreement.

(2) Title to the product of the timber included in this agreement will remain in Richard Roe until it has been paid for as herein prescribed and removed from the tree.

(3) No timber will be cupped except that on the area designated by Richard Roe, and all timber on that area will be cupped except as herein specified.

(4) No marked tree and no tree 9 inches or less in diameter at a point 4½ feet above the ground will be cupped; not more than one cup will be placed on trees from 9 inches to 14 inches, inclusive, in diameter at breast height; not more than two cups will be placed on trees from 14 inches to 22 inches, inclusive, in diameter; and not more than three cups will be placed on any tree.

(5) The greatest depth of streaks will not exceed five-eighths of an inch at any point, excluding the bark. The width of the streaks will be so regulated that not more than three-eighths of an inch of new wood will be taken off at each chipping. The faces chipped or pulled the first season will not exceed 15 inches in height from the shoulder of the first streak of the season to the shoulder of the last streak of the season, including both. The faces chipped or pulled in subsequent seasons will not exceed 16, 15, 14, and 13 inches in height, respectively, for the second, third, fourth and fifth seasons, measured in the same way. A No. 0 hack or puller will be used for chipping or pulling. Bars or strips of bark not less than 4 inches wide in the narrowest place will be left between faces, and this width shall not be lessened as the faces progress up the tree. Where more than one face is placed on a tree, one bar between them will not exceed 8 inches in width. The first streak at the base of the face will be made at the time the apron or gutter is placed. Not more than one streak will be placed on any face during any week. Faces not chipped in accordance with these specifications may be marked out and the cups removed by Richard Roe.

(6) A cupping system satisfactory to Richard Roe will be used, and the cups and aprons or gutters will be so placed that the shoulders of the first streak will be not more than 6 inches distant from the top of the cup, and the cups first placed will be as near the ground as possible. No wood will be exposed on any tree by removing the bark below the gutter or aprons.

XUM

(7) No unnecessary damage will be done to cupped trees, marked trees, or to trees below the diameter limit. Trees that are badly damaged during the life of this agreement, when such damage is due to carelessness or negligence, shall be paid for at the rate of $6 per thousand feet board measure, full scale. Trees split or windthrown because of deep incisions for raised tins will be considered as being damaged unnecessarily.

(8) No cups will be placed later than May 15, 1939, without written permission from Richard Roe, and all timber embraced in this agreement will be cupped before said date. The cupping will proceed with all reasonable speed.

(9) Unless extension of time is granted, all timber will be chipped, dipped, and scraped, the product and all cups, aprons, gutters, and nails removed, and each cupped tree thoroughly raked to the satisfaction of Richard Roe not later than December 31, 1942. Tins will be pulled out, not chopped out.

(10) No fires will be set to the timber, underbrush, or grass on the area covered by this agreement without the written permission of Richard Roe, and during the time that this agreement remains in force I will, independently, do all in my power to prevent and suppress unauthorized forest fires on the said area and in its vicinity and will require my employees and contractors to do likewise.

(11) All cupped trees will be raked in a workmanlike manner for the space of 2½ feet around each tree during December of each year of the life of this agreement; and, if required by Richard Roe a fire line not less than 3 feet wide in the narrowest place shall be hoed or plowed around the area covered by this agreement in such a manner as to completely isolate it from adjoining lands. Natural firebreaks, such as creeks, swamps, roads, etc., may be utilized with the consent of Richard Roe. These fire lines must be made and receive the approval of Richard Roe before any cups are placed the first year or new streaks made at the beginning of each subsequent year.

(12) Richard Roe reserves the right to sell or otherwise dispose of and remove or have removed all dead timber and uncupped living timber from the area covered by, and during the life of, this agreement; provided, that the removal of such material will not interfere with the operations of the purchaser.

This agreement will not be assigned in whole or in part without the written approval of Richard Roe.

The conditions of the sale are completely set forth in this agreement, and none of its terms can be varied or modified except in writing with the approval of both parties.

And as a further guarantee of a faithful performance of the conditions of this agreement, I deliver herewith a bond in the sum of $500, and do further agree that all moneys paid under this agreement will, upon failure on my part to fulfill all and singular the conditions and requirements herein set forth, or made a part hereof, be retained by Richard Roe to be applied as far as may be to the satisfaction of my obligations assumed hereunder.

Signed in duplicate this 20th day of November 1938.

JOHN DOE,
(Signature of purchaser.)
Operator.
(Title.)

Witnesses (corporate seal, if corporation).
JOHN JONES.
TOM BROWN.

SCALING LOGS AND ESTIMATING TREES

What is a log scale rule?

A scale or rule which shows how many board feet can be cut from logs of various sizes. Most commonly, the diameter of the log in inches is measured inside the bark at the small end, and the length in feet over all.

Does it make any difference what log rule is used for measuring and selling logs?

Yes; a great difference both in the amount of timber and in the resulting money return.

The Doyle rule, although in common use in the South, is unfair to the seller for logs below about 28 inches in diameter. In the early days of large and cheap virgin timber, when narrow and knotty boards were worthless, it was fairly satisfactory, but for scaling small-sized timber, such as second-growth southern pine, it gives such small volumes for small logs as to make it unsatisfactory. On the national forests the Scribner rule (in the decimal C form) is standard. It is more fair than the Doyle rule for small logs, but reasonably careful sawing should result in obtaining from 10 to 20 percent more lumber than even this rule gives for second-growth timber.

TABLE 2.—*Contents of logs scaled by the International log rule (using saw cutting ¼-inch kerf)*

Diameter at top end of log inside bark (inches)	Contents of logs having a length of—						
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
6	7	10	13	16	19	23	27
7	12	15	19	24	28	33	39
8	16	21	27	33	39	45	52
9	23	29	36	43	51	59	68
10	29	37	45	54	64	75	86
11	36	46	57	68	80	92	105
12	44	57	70	83	97	111	127
13	52	68	83	100	116	133	151
14	62	80	98	117	136	156	176
15	73	94	114	136	157	180	204
16	84	108	131	156	181	207	233
17	96	123	149	177	205	235	265
18	110	139	169	201	232	265	299
19	123	156	190	225	261	297	335
20	138	174	212	251	290	330	372
21	152	193	234	279	321	366	412
22	168	214	259	307	354	404	453
23	186	235	285	337	388	442	497
24	203	257	311	367	424	481	542

For small timber, such as second-growth pine, the International log rule (table 2) gives log volumes which are very close to what can be sawed out by using good methods. Careless sawing will give a lower volume of square-edged boards than the logs scaled by this rule, so that it gives the millman a chance to test his own efficiency in this respect. Producers of small logs will benefit when this or some equally close rule has come into general use. The sale of logs by the International rule is recommended.

As a comparison, a log measuring 10 inches in diameter inside the bark at the small end and 16 feet long, when carefully sawed with a circular saw of ordinary thickness (¼-inch kerf) should, according to the International rule, turn out 64 board feet. For the same log the Doyle rule (table 3) would show 36 board feet, or only about one-half the amount that can be actually sawed and that is credited to it by the International rule.

TABLE 3.—*Contents of logs scaled by the Doyle log rule*

Diameter at top end of log inside bark (inches)	Contents of logs having a length of—						
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
6	2	2	3	3	4	4	5
7	4	5	7	8	9	10	11
8	8	10	12	14	16	18	20
9	12	16	19	22	25	28	31
10	18	22	27	31	36	40	45
11	24	31	37	43	49	55	61
12	32	40	48	56	64	72	80
13	40	51	61	71	81	91	101
14	50	62	75	87	100	112	125
15	60	76	91	106	121	136	151
16	72	90	108	126	144	162	180
17	84	106	127	148	169	190	211
18	98	122	147	171	196	220	245
19	112	141	169	197	225	253	281
20	128	160	192	224	256	288	320
21	144	181	217	253	289	325	361
22	162	202	243	283	324	364	405
23	180	226	271	316	361	406	451
24	200	250	300	350	400	450	500

How are logs scaled?

The diameter of the small end of the log inside the bark is measured in inches, and its length is taken in feet. If a scale stick is used, the contents of the log are read directly from the stick. These readings are for straight and sound logs. Thus the scaling of sound and straight logs is a simple matter. Experience and special knowledge are required to determine the allowance that should be made for defective logs. Slash pine logs average high in freedom from rot.[6]

How many board feet of saw timber can be cut from logs and slash pine trees of various sizes?

Much depends on the degree of care exercised, the kind of saw used, and the amounts taken from, and left in, the woods. The International rule (table 2) shows how many board feet of lumber can be sawed from straight and sound logs of different sizes with a circular saw cutting a ¼-inch kerf, all the usable lumber being taken. This rule shows not what is being cut by wasteful methods but what can be sawed out to meet the present conditions of good utilization. A deduction should be made for crook and defect.

To estimate the board-foot contents of a tree, the diameter in inches outside the bark (at breast height, or 4½ feet above the ground) and either the number of 16-foot logs or the total height of the tree should be ascertained. For example, as shown in table 4, the contents of a 14-inch tree having three 16-foot cuts is 129 board feet, or if the tree is 70 feet in height it contains 146.6 board feet. Or, if the total height of the tree and the breast-high diameter (outside the bark) are known, the contents can be estimated by referring to table 4, likewise based upon the International log rule. For example, a slash pine 16 inches in diameter and 70 feet in total height will cut out about 186 board feet, if each log is straight and sound.

[6] For more information regarding how to scale logs and estimate standing timber, consult Farmer's Bulletin 1210, Measuring and Marketing Farm Timber.

TABLE 4.—*Saw timber contained in slash pine trees of (1) various diameters and number of 16-foot logs in tree, and (2) various diameters and total height of tree*

Diameter of tree outside bark at breast height (inches)	Contents of trees[1] having—											
	Specified number of 16-foot logs					A total height of—						
	1	2	3	4	5	40 feet	50 feet	60 feet	70 feet	80 feet	90 feet	100 feet
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
7	18	27	42	.....	.....	9.05	12.67	17.20	23.53	30.77	.....	.....
8	20	34	52	.....	.....	14.48	20.82	28.96	38.01	47.97	.....	.....
9	23	39	63	88	.....	21.72	30.77	41.63	53.40	66.97	.....	.....
10	25	44	76	106	139	27.15	41.63	55.20	69.68	88.69	104.98	123.08
11	.....	51	88	125	166	.....	.....	69	88	110	131	156
12	.....	57	101	146	192	.....	.....	84	107	133	159	186
13	.....	62	115	170	221	.....	.....	100	127	157	187	221
14	.....	70	129	187	250	.....	.....	116	147	180	216	253
15	.....	76	143	211	282	.....	.....	131	167	205	246	290
16	.....	83	160	234	314	.....	.....	148	186	229	274	344
17	.....	.....	177	261	348	.....	.....	163	205	253	304	362
18	.....	.....	193	287	384	.....	.....	179	226	278	333	396
19	.....	.....	212	315	422	.....	.....	195	246	302	362	431
20	.....	.....	231	345	463	.....	.....	212	266	327	391	465

[1] By the International log rule. Circular saw, ⅛-inch kerf. Full scale for straight and sound logs. Make deduction for crook and defect in trees. For contents of trees using band-saw (⅛-inch kerf) add 12 percent.

How many slash pine trees will be required to make a cord of wood?

That depends on the size of the tree or trees. If one knows what fraction of a cord of wood is contained in trees of different specified sizes, then he can easily get the desired number of trees. Table 5 gives the fraction of a standard cord (a stack of wood 4 by 4 by 8 feet) which different-sized trees contain when worked up in usual sizes of 4-foot wood with the bark. For example, a tree 12 inches in diameter (at breast height) and 60 feet in total height, if of normal or average shape, when worked up into cordwood with the bark on, contains about 0.218 cord. This is slightly over one-fifth of a cord, or five trees of this size will make a little over a standard cord.

Or, figuring in another way, a 10-inch tree 50 feet in height contains about 0.12 cord; therefore, eight such trees would cut up into about a cord. Or, four 13-inch trees 60 feet in height would make a cord, since one tree contains one-fourth of a cord.

A person can thus measure the trees that should be thinned out for pulpwood or fuel wood, tally them by diameter and heights, and quickly calculate about how many cords they will make.

Various kinds of tree-scale sticks, or cruising sticks, are coming into use in measuring the diameter and the height, or the number of logs, in a tree. Some of the sticks also show for trees of different diameters and number of 16-foot cuts, the number of board feet of saw timber that can be cut out. Information as to sources of tree-scale and log-scale sticks and their use can be obtained from State forestry departments, the extension services of State colleges of agriculture, or the Forest Service, United States Department of Agriculture.

TIMBER PRODUCTION PER ACRE

Many stands of slash pine of known ages have been studied and measured to find out how much timber they will yield per acre. In this the forester deals with fully stocked stands, or those which have no blanks or spots without trees. The quantity of timber is measured

in the standing trees, either in cords, cross ties, or lumber. With the figures so obtained it is possible to predict the rate of growth and the quantity of timber there should be on an acre at different ages.

How many cords of wood will an acre of slash pine produce?

A fully stocked stand of slash pine 20 years old on poor land should cut out per acre about 20 cords of wood (with the bark on); on average land about 35 cords, and on good land about 46 cords (table 5). The average growth of fully stocked stands is thus from 1 to 2 cords per acre per year of wood such as is often wanted for paper pulp and fuel wood. It will be seen in table 6 that an acre of average land will produce slightly more than a cord a year in stands between the ages of 15 and 50 years; also the highest average rate of production of cordwood comes very early when the trees are not older than 15 years. Most stands are not fully stocked and produce less per acre.

TABLE 5.—*Cordwood (pulpwood, fuel wood, etc.) contained in slash pine trees of various sizes*

Diameter of tree, outside bark, at breast height (inches)	Standard cords in trees [1] having a total height of—							
	30 feet	40 feet	50 feet	60 feet	70 feet	80 feet	90 feet	100 feet
	Cord	*Cord*	*Cord*	*Cord*	*Cord*	*Cord*	*Cord*	*Cord*
5	0.018	0.027	0.037	0.047				
6	.025	.036	.049	.064	0.079			
7	.032	.048	.064	.083	.103	0.120		
8	.042	.060	.080	.105	.132	.151		
9		.07	.10	.13	.16	.19	0.22	
10		.09	.12	.16	.19	.23	.26	
11		.11	.15	.19	.23	.27	.31	
12		.12	.17	.22	.26	.31	.36	0.39
13			.20	.25	.30	.36	.41	.45
14			.23	.29	.35	.41	.49	.51
15			.26	.33	.39	.46	.52	.58
16			.29	.36	.44	.51	.58	.64
17				.41	.49	.57	.64	.71
18				.46	.54	.62	.71	.78
19				.49	.59	.68	.78	.86
20				.53	.65	.75	.85	.94

[1] Standard cord of 128 cubic feet of wood (with bark).

TABLE 6.—*Cordwood yield per acre of slash pine at different ages, in well-stocked stands, or about maximum yields* [1]

Age of trees (years)	Wood with bark			Peeled wood		
	Good land	Average land	Poor land	Good land	Average land	Poor land
	Cords	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*
15	37	27	12	29	20	9
20	46	35	20	35	25	14
25	53	42	26	41	31	18
30	59	48	32	47	37	23
35	66	54	36	53	42	27
40	72	58	40	58	45	30
45	77	62	43	62	49	32
50	81	65	45	66	51	34
55	84	67	47	68	54	36
60	86	69	48	71	56	37

[1] Includes the wood from all trees 4 inches and over in diameter.

The number of trees at any given age required to cut a cord can be easily calculated from the last column of table 1. For example, at 20 years of age on average land, fully stocked slash stands contain

about 150 trees per acre. If the stand on average land at that age cuts about 35 cords (column 3 of table 6), the average tree will cut out about one-fifth of a cord, or it will require about 5 trees to make a cord

How much saw timber will an acre of slash pine produce?

The owner or the prospective buyer of timberland should know its capacity for producing timber. Fortunately, the amount of slash pine timber that can be grown per acre can be predicted because of studies which have been made of many well-stocked, well-set, or dense stands. Table 7 shows the amount of saw timber that stands may be expected to cut at various designated ages. The figures do not include the timber removed in previous thinnings, or the intermediate yield, often a very considerable amount. It is regretted that the rate of timber production for unburned stands is not known, as it would be somewhat larger.

An acre of average-grade land well set in slash pines—for example, 30 years old as shown in table 7, column 3—should cut out an average of 11,800 board feet if all the trees measuring 7 inches and over are carefully sawed. This, in round figures, is an average growth of 400 feet a year. If the logs were scaled by the Doyle rule and only the trees that measure 9 inches and over in diameter at breast height were counted, the timber on the acre would scale only about 1,500 board feet. But the scale shown by the Doyle log rule is too low, and the cut would actually be more.

TABLE 7.—*Saw-timber yield per acre from full stocked slash pine stands at different ages*

Age of trees (years)	Actual cut by careful sawing [1] (mill tally)			Logs scaled by the Doyle rule [2]		
	On good land	On average land	On poor land	On good land	On average land	On poor land
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
15	4,900	1,400	------	------	------	------
20	9,500	3,600	450	1,000	------	------
25	15,800	7,200	1,800	3,500	------	------
30	21,700	11,800	3,600	7,000	1,500	------
35	26,700	15,800	5,400	11,000	3,500	------
40	31,200	19,900	7,700	14,500	6,000	500
45	34,800	23,100	10,000	17,500	8,000	1,500
50	37,100	25,300	11,800	19,500	10,000	2,000
55	39,400	27,600	13,100	21,500	11,500	3,000
60	41,200	29,000	14,500	23,000	12,500	3,500

[1] All trees 7 inches d. b. h. and over, per acre, International rule, ⅛-inch saw kerf.
[2] All trees 9 inches d. b. h. and over, per acre, Doyle log rule.

Slash pine, when grown in well-set or dense stands and protected from fire, should grow on the lower grades of land, or situations, 1 cord a year per acre, or from 300 to 500 board feet. Such well-set and protected stands on average to good-grade lands should produce up to 2 cords an acre a year, or from 500 to 800 board feet. Such stands of natural origin are not common. Planted slash pine stands under protection and management quite commonly are producing timber at these rates.

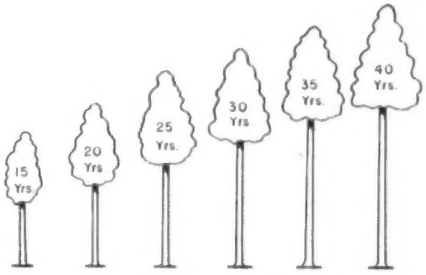
At 40 years a fully stocked acre of slash pine (table 7) on good land should cut about 31,200 board feet, an average of 780 board feet a year; on average land 19,900 board feet, or an average growth of

about 500 board feet a year; and on poor land about 7,700 feet, or an average yearly growth of 192 board feet (fig. 21). These illustrate well the wide differences in growth due to different conditions of soil, soil moisture, and climate. Conditions often vary widely in the same locality.

A caution here is advisable. These figures show what would be the yield if all the trees were sound and straight. A slight allowance for seen and unseen defects in the logs is necessary, or the scale will be somewhat too high.

What are some examples of stands actually measured?

The following essential facts concerning a few of the stands actually measured will serve as an illustration of what yields per acre may be



AVERAGE						
HEIGHT OF TREE (feet)	39	48	56	63	69	73
DIAMETER, breast height (inches)	7	8	9.5	10.5	12	13
CORDWOOD PER TREE (with bark)	0.05	0.08	0.13	0.17	0.26	0.31
CORDWOOD PER ACRE (with bark)	27	35	42	48	54	58
BOARD FEET PER TREE	9	20	42	66	105	133
SAW TIMBER PER ACRE (board feet)	1,400	3,600	7,200	11,800	15,800	19,900

FIGURE 21.—Average size of slash pine trees, their contents in cords and in board feet, and the amount of cordwood or lumber per acre at various ages. (See tables 1, 4, 5, 6, and 7.)

expected from well-stocked slash pine stands, such as are locally considered to be dense stands.

(1) A 21-year-old stand, consisting of 384 trees per acre, averaging 8 inches in diameter at breast height and 56 feet in height, contained 45 cords of wood with the bark on, or 34 cords of peeled wood. If all trees measuring 10 inches and over in diameter were cut, the stand would saw out about 6,400 board feet; or if all trees 8 inches and over were taken, it would saw about 10,300 board feet. By the Doyle log rule, however, all trees measuring 8 inches and up in diameter would scale only 3,700 board feet. This was on good land, giving about maximum yield.

(2) A 25-year-old stand, with 274 trees per acre, averaging 63 feet in height and 9 inches in diameter, containing 47 cords of wood with the bark, or 37 cords of peeled wood. The trees 10 inches and over in diameter would saw out, down to small top diameters, about 10,700 board feet per acre; or about 13,500 feet would be obtained if trees 8 inches and up in diameter were taken. If the logs in the trees measuring 8 inches and over in diameter were scaled by the Doyle rule, there would be only 5,800 board feet per acre.

(3) A 26-year-old stand with 754 trees per acre would cut 64 cords of wood with the bark, or 47 cords of peeled wood. There would be a total of only 1,300 board feet if trees measuring 10 inches and up were taken; or 8,000 feet from all trees 8 inches and over in diameter, as compared with only 1,360 feet by the Doyle rule.

(4) A 30-year-old stand, with 114 trees per acre, averaging 11 inches in diameter and 69 feet high, contained 31 cords with the bark, or 25 cords of peeled wood. There would be 9,672 board feet per acre of saw timber in the trees 10 inches and over in diameter, or 10,700 board feet in the trees 8 inches and over in diameter. If scaled by the Doyle rule, the stand had only 5,700 board feet.

(5) A 51-year-old stand, which consisted of 220 trees per acre, averaging 70 feet in height and 9.4 inches in diameter, contained 57 cords of wood with the bark, or 44 cords of peeled wood. The stand would cut out 10,100 board feet from all trees 10 inches and over in diameter, or 14,600 feet from trees measuring 8 inches and over. The Doyle rule gave only 5,900 feet of saw timber.

REFORESTATION BY NATURAL METHODS

The natural restocking of slash pine lands with young growth may be expected to take place satisfactorily whenever enough seed trees are left in logging. Young slash pine rapidly takes possession of old fields, wet lands, vacant lands near towns, and places protected from fire. Such reforestation, however, is not proceeding everywhere as there has been too-heavy cutting in some places and occasional fires (fig. 22).

There are still large areas of practically idle land in the South which should be growing timber. Many owners of small tracts and some owners of large ones are, however, seeking information and are taking active steps toward getting young pine growth to come back on their lands.

Where do the seeds come from?

Seeds come from the cones, or burs, which mature and open in the fall. Each scale bears two seeds in hollows, or pockets, at its base, which may easily be seen upon examining an open bur. However, scales near the tip and base of the bur commonly do not bear fertile seed. The burs start from very small female flowers that have been fertilized by pollen from the male flowers, and they require two seasons to mature. The pines all bear male and female flowers separately, but both kinds on the same trees.

How much seed do slash pines produce?

Slash pine is a somewhat heavy seed producer. Full or heavy seed crops may be counted on at intervals of 2 to 3 years, although some seed is borne almost every year. Well-developed cones, or burs, have been observed on trees 12 years old, but in general trees growing in the open produce seed only after reaching the age of 15 to 18 years. In close stands seed production is usually limited in quantity and begins at a little later age. The seed is small and is provided with a wing by which it is easily carried on moderate winds a distance two or three times the height of the tree or occasionally much farther (fig. 2). As a result the seeds are widely dispersed.

The number of seeds in a pound varies widely but averages about 15,500, approximately 80 seeds in every 100 being fertile. There are about 215 ripe closed burs in a bushel, the average weight of which is

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FIGURE 22.—Natural regeneration of slash pine: *A*, Good stand of slash pine resulting from plenty of seed and protection from fire; *B*, Cutting for pulpwood, leaving no seed trees to restock the land.

about 34 pounds (24 to 45 pounds). A bushel of burs will yield about 1⅛ pounds, or 18,600 seeds, an average of 87 seeds per bur. In size and appearance the seed of slash pine closely resembles that of loblolly pine, with which it is likely to be confused. The wings of slash pine seed are easily removed—more easily than those of any other kind of southern pine.

Can the seed be kept in storage?

Slash pine seed retains its vitality well in storage. The best known storage is to place the seed, after thorough drying, in tight containers and keep it at as low a temperature as can be found, preferably in cold storage at a temperature of about 25° to 35° F. If cold storage is not available, the cans or jars might well be kept in a vegetable cellar or pit. The latter storage is satisfactory for seed kept over the first winter; the former should be used to keep seed for use the second spring after collecting.

When and where do the seeds germinate?

Slash pine seeds, like longleaf, mostly germinate in the fall within a month after they reach the ground. If the seed crop is heavy and the fall rains favorable, as they are every few years, full stands of young trees result. Conditions favorable for protection from fire also account for the abundance of slash pine in moist situations and its relative scarcity on dry soils. The broad margins of bodies of water, grass bogs in swamps, and flatlands likely to be water-soaked for some time are favorite situations for reproduction. Cultivation of abandoned fields disintegrates the underlying hardpan and affords moisture conditions favorable for seedbeds. Young slash pine growing on such fields is commonly termed "old-field" pine. Fires, which fortunately are becoming less common, are still destroying vast numbers of young pines of the different species.

Can slash pine be grown successively as a crop?

With a kind of tree which seeds as abundantly as does slash pine, there is very little difficulty in growing one crop after another on the same land. Two necessary requirements for establishing a young stand are an adequate supply of seed on open ground and protection against fire. Like all the pines, the best production of slash pine comes from having even-aged trees in fairly close stands.

If a stand of pine trees is cut clean, there will be little or no young growth except where the trees are cut in the fall after the ripening of a good crop of seed. Since logging usually breaks up the surface soil the ideal time to cut the final crop or stand of trees would be during the 2 or 3 weeks while the ripened burs are opening in early fall. This would be just ahead of the period of seed germination and establishment of the young tender seedlings. Reference might well be made to the subject as found on page 37.

PLANTING SLASH PINE

The absence of seed-bearing trees on or near heavily cut or burned-over timberland, or worn-out or idle farm land makes it necessary to start young forest growth by planting small trees or sowing the seed on the land. Slash pine is especially well adapted to reforesting lands by planting young seedlings. Young slash pines have taproots and stand transplanting well if ordinary care is taken, as is shown later.

Is direct seeding of land advisable?

Direct seeding is advisable only under special conditions. In wet or crawfish land in the Coastal Plain of South Carolina and Georgia, satisfactory results have been obtained by direct sowing of slash pine seed. Early November sowings have proved more success-

ful than those made in late March or early April. Sowings made with about 2 pounds of seed broadcast in 1-year rough grass, on low, poorly drained lands have given satisfactory stands; also fair stands have resulted from sowing 1 to 1½ pounds of seed, in hoed spots with 10 seeds to the spot and 1,000 spots per acre. A fairly open stand of grass acts as a protection against sun and wind in affording moisture in the air and modifying extremes of temperature. Pine seed should never be covered more than very lightly.

In seed-spotting low wet land a good method is to scatter 8 to 10 seeds on loose soil and press them in with the foot without any, or with only a slight scattering of soil over them. Owners of recently abandoned pieces of farm land can expect satisfactory results from broadcasting 1 to 2 pounds of slash pine seed in the late fall and harrowing them in like a grain crop.

However, the seed-sowing method is regarded generally as uncertain and less satisfactory than the planting of small tree seedlings. If germination is successful, the method requires considerable labor in thinning out the excess seedlings in order to secure a stand of the desired density. If a dry period follows the sowing, germination may be so delayed as to result in a loss of the seed by insects, mice, or birds. This result has been reported as prevailing in the lower parts of the States bordering the Gulf of Mexico.

Direct seeding of slash pine might well be tried on a small scale or experimentally on wet flatlands or low old fields by landowners interested in securing another crop of trees.

Is the planting of small trees a good method of reforesting land?

The planting of small trees is in general practice in the Coastal Plain—the home of slash pine. Slash pine is one of the easiest of all the pines to grow from seed and set out much like setting cabbage or tobacco plants. Successful and extensive plantations of 1-year-old seedlings have been made in the Coastal Plain from South Carolina to Louisiana. In the latter State one lumber company has more than 12,500 acres of hand-planted young slash pine forest.

HOW TO GET PINE SEEDLINGS

How can slash pine seedlings be obtained?

Small year-old seedlings can be dug up in openings or along the edges of old fields near seed trees, or grown in a nursery bed at home, or purchased at nominal cost from the State forestry departments of the various States. Nursery-grown stock on the whole has proved more satisfactory and usually cheaper than wildling seedlings, which often have poor root development. If the acreage to be planted is large, it will probably pay to establish a local nursery and grow the trees. In any case it is advisable to write to the State forester of your State forestry department, or apply to the local county agent for advice and publications on how to get a supply of seedlings, and how to plant them. Applications for seedling trees should be made to the State forester several months in advance of midwinter or early spring—the best times for planting. Your county agent is in a position to assist you in all phases of growing timber as a crop on the farm, as he is in touch with the State extension forester. There are State or United States Department of Agriculture publications on nearly every phase of reforestation available free upon request to your

State forestry agencies, or to the Office of Information, Department of Agriculture, Washington, D. C.

Where can one get slash pine seed?

Pine seed may be collected from the trees or purchased from some of the State forestry agencies or from commercial seedsmen. It is usually an advantage to plant seed grown in the locality or nearby region. Information about crops of slash pine seed will be found on pages 33 and 34.

The seeds ripen and the burs turn brown in late summer or early fall. A good time to begin collecting is when the first bur in the locality begins to open. Another good test of the right time to begin collecting is whether the burs are ripe enough to float on water immediately after picking. The collection period usually lasts from 3 to 5 weeks. Pine seed is most economically obtained from tops of trees felled in logging. The burs should be pulled off and collected in gunny sacks, buckets, or tubs, and later spread out to dry on a tight floor or on canvas or sacking in the sun. In drying weather they will open in a few days, and if stirred or shaken the seeds will fall out. Each seed has a wing, and the mass of seed should be winged by being rubbed over a screen or between the hands and then winnowed in a steady gentle breeze or in a grain fanning mill. Seed with the wings on are unsatisfactory for direct seeding or use in nursery beds.

Commercial prices of seed range mostly from $1 to $3 per pound. In good seed years, supplies of seed may be collected and cleaned at a cost of not more than $2 per pound, if logging operations are under way so that burs can be picked off the tops of trees felled in logging. If the trees have to be climbed in order to gather the burs, the cost may go up to $3 or more per pound. Often the burs can be obtained by paying collectors from $0.75 to $1.25 per bushel, depending on the abundance and ease of collecting. One year, following a tropical hurricane, burs were obtainable in abundance for 50 to 75 cents per bushel. A bushel generally yields from 1 to 1¼ pounds of good seed. Occasionally, in dry years, pine seeds do not fill out well and are of poor quality.

How can one grow pine seedlings?

Most of the various types of nursery beds are well adapted to growing slash pine. A commonly used type consists of an ordinary bed, flat or even with the paths, or slightly raised and bordered by a curbing of 1 by 4 inch boards set 2 inches in the ground, thus holding in the soil. A width of 4 feet is standard for seedbeds (fig. 23). A sandy type of soil is much better than clay soils.

The soil should be worked well in the fall and again in the spring. Acid soils are very desirable, as damping-off fungi are common and thrive in alkaline or sweet soils. On farms the beds should preferably be located near the house, so as to be easily watched and tended, and a supply of water for use during extra-dry spells is desirable, especially during seed germination and summer droughts. All large nurseries must have adequate watering systems.

In early spring seed of good quality should be broadcast evenly on well-prepared beds at the rate of a pound (about 15,500 seeds) to each 144 square feet of seedbed (4 by 36 feet). Or the seed may be

drilled in rows spaced 6 inches apart. At the rate of 60 seeds per lineal foot of drill 1 pound of seed will be enough to drill a bed 4 feet wide by 32 feet long. The goal in seeding is to produce a crop of

FIGURE 23.—Growing slash-pine seedlings in nursery beds: *A*, One-year-old trees in Georgia State nursery ready for planting. A full stand has about 40 seedlings per square foot, but losses due to insects or disease may reduce the final crop. *B*, Small farm nursery bed of yearling seedlings in northern Florida, being viewed by interested visitors.

about 40 seedlings per square foot (broadcast), or about 20 seedlings per linear foot of drill. This is equivalent to a total of 5,760 per pound of seed sown broadcast (4- by 36-foot bed), or 5,120 per pound sown in drills (4- by 32-foot bed). With less intensive care in the

nursery and seed of lower grade the amount of seed to be sown per unit of seedbed area should be relatively increased by at least one-half pound. Losses may be expected because of infertile seed, fungi, and insects.

After being sown, the seeds are pressed into the soil by a roller, plank, or spade, and then are covered very lightly with sand and a single layer of burlap (gunny sack) or by a medium layer of fine woods litter or pine straw. The material should be as free as possible of weed seed. Sand from stream banks is well suited for use in nursery beds.

How should nursery beds be protected and cared for?

The sown beds should be watched closely, carefully protected, and watered in case of hot, dry weather. The period during the germination of the seed is especially critical, when an adequate supply of water will often mean the difference between success and failure. If a burlap cover is used, it should be removed as soon as the seeds begin to germinate, as the seedlings rise in the seed shells much as do those of cucumbers and watermelons.

Birds, mice, and insects are likely to be pests. A shotgun, traps, and poison are means of fighting these enemies. The period of germination of slash seed is usually 2 weeks or less, so that expensive wire-screened frames over the seedbeds are not necessary. Shading by screens also is unnecessary in a slash pine nursery. Ants sometimes cause much damage but may be controlled by bait poisoning. Moles sometimes cause trouble and may be kept out by encircling the bed with a narrow trench filled with lime, or by sinking a strip of half-inch wire mesh to a depth of 1 foot around the bed. The damping-off fungi are likely to attack the tender stems just below the surface when the seedlings are up to 2 weeks old. Better ventilation and drying of the surface soil is helpful. Acid soils are the best for pine nurseries; therefore never apply lime as a deterrent to this class of injurious fungi.

In parts of Louisiana and Texas a leaf-eating ant often injures or kills young slash seedlings. The control consists of pouring about one-tenth of a pint of carbon disulphide down each hole or opening to the den of the ant colony. A one-quarter-inch hard-rubber hose with a funnel inserted at one end is used. All surface openings are then closed or covered with sod. A gas is formed, killing the ants. The liquid is highly explosive, necessitating great care in handling. The cost is about 3 to 5 cents per opening.

For further information on fighting any pests of the nursery, application should be made to your local State forester or to the United States Department of Agriculture, Washington, D. C.

All weeds should from the start be pulled out when small; otherwise weeding will greatly injure the small pines. Watering during hot, dry spells is very advisable. A dense stand of seedlings such as should be growing in the beds requires much soil moisture. A gentle but thorough watering at intervals is much better than a mere surface wetting every day, and requires less time.

HOW TO PLANT PINE SEEDLINGS

When is the best time to plant pine seedlings?

In December, January, and February, before the buds begin to swell, conditions are most favorable for planting slash pine seedlings.

Late fall planting may give good results if the season happens to be wet and the winter mild, but much injury may be expected during a dry fall and during a severe winter, because of hard freezing and the

FIGURE 24.—A slash pine nursery of a Louisiana lumber company: *A*, Digging, or lifting one-season-old slash pine seedlings. The soil is carefully loosened and the trees lifted without injuring the roots. *B*, The roots and stems are wrapped in wet sphagnum moss or in burlap, and the bundles are placed in crates for delivery at the planting places. In this nursery 7,000,000 slash pine seedlings are grown.

resulting upheaval of the soil. If planted in the late spring, after the new growth has started, pine seedlings are likely to make a poor growth or die during dry weather.

What are the important steps before planting pine seedlings?

One-season-old slash pine seedlings are best for planting. At the end of one growing season they should be from 8 to 10 inches in height—sometimes higher.

The seedlings should be carefully dug and lifted from the nursery bed in order to avoid as fully as possible breaking the fine rootlets (fig. 24, *A*). All underdeveloped seedlings should be thrown away as culls, since it is an expensive mistake to plant spindling or sickly small trees. The taproot, if over 8 inches long, should be pruned back with a sharp knife. It is of the utmost importance that the roots at all times be kept wet; hence the dug seedlings should at once be placed in tubs or buckets with water, or wrapped in wet moss or gunny sack (fig. 24, *B*). If not wanted at once for planting, the seedlings should be heeled in, in fresh soil, always in a cool, shaded place, and the soil never allowed to dry out. The leaves should be left freely exposed to the air but not to direct sunlight.

The desirability of breaking or preparing the soil for planting small trees depends upon the character of the soil. If the soil is sandy or open, little is gained by plowing. If the land is rough with stumps and bushes, the trees may be planted without soil preparation. If, however, the soil is dense and has an impervious layer, it is well to break it deeply and open it up well in clods. This should be done when the soil is dry, preferably in the fall, some weeks ahead of time to plant the trees. This interval enables the soil to loosen and greatly aids in stimulating early root development.

Plows for use in preparing the soil vary with the conditions. On land that has been in cultivation in recent years, a 6- or 8-inch ripper, or pointed shovel, should be used on the point of the plow stock, and on the heel should be attached a 10- or 12-inch scraper, or wings. On land that has never been broken and is dense, a one-horse or, better, a two-horse turning plow should be used in making a round trip or two furrows. Better preparation is to go one way with a middle-buster and follow with the ripper and scraper on a plow stock, as previously described.

In planting trees, what spacing is best?

Opinion varies widely as to the most desirable spacing to be used in planting slash pines. A natural loss must always be reckoned with, varying usually from 10 to 20 percent. If the trees are planted 6 feet apart in rows 6 feet apart, 1,210 will be required to plant an acre. This is about the largest number of trees that should be planted, and it should allow for thinning out many trees as the stand develops, for pulpwood or fuel wood.

A planting of 1,000 seedling trees per acre would seem to be more desirable. Setting the trees a scant 5½ feet apart in rows spaced 8 feet apart will require 1,000 trees. Or planting them about 6½ feet apart in rows 6½ feet apart will require the same number.

A spacing of 8 by 8 feet, requiring 680 seedlings, has been extensively used in commercial plantings. The practice is now to use more trees, particularly in plantings by farmers, so as to get more wood from thinnings.

In the planting in southern Georgia referred to on page 45, the trees were set 5 feet apart in furrows 10 feet apart, or 870 to the acre. The plan was to turpentine and thin out each alternate tree as soon

as possible, leaving a stand of 436 trees, spaced 10 by 10 feet apart, for future development and working. The 10-foot lanes afforded driveways for the removal of turpentine and timber.

One essential should always be kept in view; namely, when it comes to working the trees for turpentine it is desirable to have frequent lengthwise or parallel openings as driveways, say at least 10 feet wide. These can be obtained by cutting out a row occasionally as required in any of the previously mentioned spacings of plantings. Some advise leaving a 10-foot opening every third or fourth row when planting.

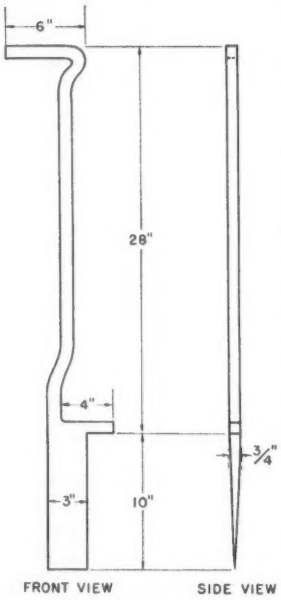


FIGURE 25.—A good kind of planting bar, or dibble, for use in the South for planting small pines. This type is being used rather extensively and with good results. The planting bar is made of two pieces of steel shaped and welded as described on this page.

What tools should be used for planting?

A mattock or a grub hoe is often used to good advantage in planting. Sometimes a spade or a shovel is employed because it is at hand, but neither is well adapted to the purpose. In most soils in the South, planting—which is done in midwinter or early spring, when the soil is moist—can best be done with the use of a planting bar, or dibble. A good planting bar, as shown in figure 25, can be made by forge-welding a heavy, carbon tool-steel blade to a shaft of steel tubing. The blade should be 3 inches wide by 10 inches long and ¾ inch thick at top, hammered to shape, ground to a tapering lower edge, and heat-treated for hardness. A foot pusher is made at the top of the blade, 4 inches in length by ¾ inch in width. The handle is of 1¼-inch (or 1½-inch) tube steel, about 28 inches long, making the tool 38 inches in length. The top of the tube is shaped to a crook and horizontal bar for use as a handle.

Various commercial tool companies make and sell planting bars. Their names and addresses can be obtained upon request from State or Federal forestry agencies.

In using the planting bar a slit is opened, the little tree is held in place by the man or boy carrying the bucket of trees, a second slit is made 3 to 5 inches from the first, and the handle moved away from the first slit so as to pinch the soil tight against the roots. The second slit is closed with the heel of the shoe.

How should pine seedlings be planted?

The essential aim of good planting is to leave the trees tightly set in the ground, at the same height that they stood in the nursery, with the least possible injury to the fine rootlets (fig. 26).

Roots must always be kept moist during planting and spread out in the hole or slit rather than bunched. Afterward the soil should be well firmed about the tree to avoid rapid drying.

One method of planting small pines is for 2 men to work together as a crew—1 making the holes and 1 carrying a bucket of trees and planting them. The bucket should have water, or better, a thin clay puddle. A 2-man crew using a mattock in average sandy soil can plant 1,000 to 1,400 trees a day or, using a dibble and having the work well organized from 1,400 to 2,000 trees. If a mattock is used, the holes are often dug larger than is necessary. They should be dug as shown in figure 27, only a little larger than necessary to spread out the roots in a natural position, with the taproot straight down. The soil is then scraped in about the tree, which should be set fully as deep as it grew in the nursery bed or woods and be well firmed with the foot (sole or heel of shoe) so as to prevent drying out. Some straw, grass, or loose soil scraped about the tree will be helpful in acting as a mulch to prevent too-rapid drying (fig. 28).

Advantage should be taken of favorable weather. Cloudy weather following rains affords ideal conditions. After planting no further attention is necessary, except protecting the trees at all times from fire and from hogs or other injurious livestock.

No livestock should be permitted to run over land set in pines for at least the first 5 years. Watering and cultivating the trees in a forest plantation are both impracticable from a financial standpoint and should not be attempted. The case is different where a few trees are set out for ornamental purposes.

In a forest plantation loss of up to 15 percent of the total number of trees set out is not an uncommon experience. Among the common causes are the poor grade of trees used, careless planting, and drought at the time of planting or soon after. If any considerable loss occurs, it is good practice to reset the blank places the next spring or a year later. The importance of fire protection is discussed on page 46.

COST OF PLANTING PER ACRE

In estimating the cost per acre of planting pine seedlings, much depends upon the size of the operation and the kind of soil and its condition. Experience shows that some farmers have found it cheaper to dig wild seedlings, while many more landowners have found it much better and cheaper in the long run to plant only thrifty nursery-grown stock because of its better root development. Such trees may be grown at home, or in most States they may be purchased from the State forestry commission.

Assuming a cost of $2.50 for a thousand nursery-grown seedlings, 680 trees per acre (spacing of 8 by 8 feet) will cost about $1.70. The cost of his mule team for an hour in furrowing an acre of land will be regarded by the average farmer as a small item. To plant 680 seedlings should take 2 men less than one-half day. The total cost, if the labor is figured at $1.50 per man per day, would amount to from $3.50 to $3.85 per acre, or about $4 if the land is furrowed. This is believed to be a conservative figure. If the spacing 6 by 6 feet is chosen (1,210 trees per acre) the corresponding cost would be about $5 per acre.

With spare hands and teams in winter the farmer may be able to reduce the cost somewhat. Probably the planting of 1,000 seedlings per acre (6½ by 6½ feet) can be done at a total cost of less than $5. Planting cut-over land on a large scale, one lumber concern in Louisi-

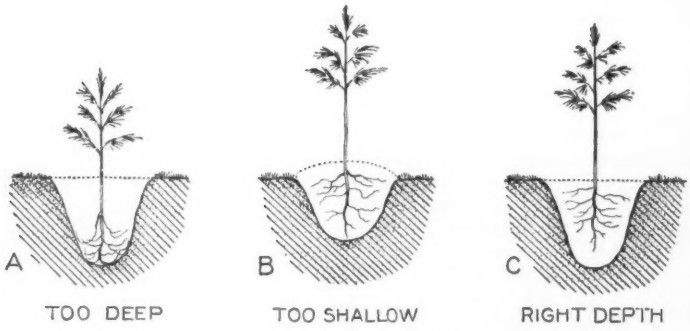
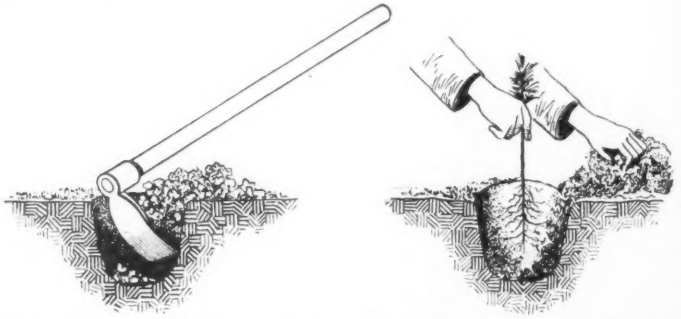


FIGURE 26.—The seedling trees should be set a little deeper than they grew in the nursery or woods as shown in *C*. Doubling up the taproot as in *A*, is extremely injurious, and if set too high, as in *B*, the tree is likely to fall over in a wind or dry out and die.



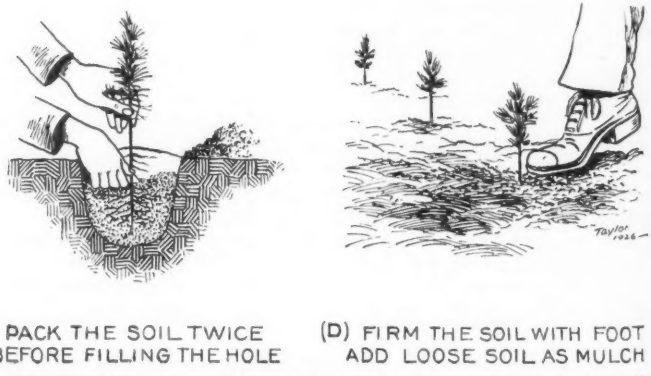


FIGURE 27.—Planting pine seedlings with a mattock or grub hoe in land that has not been treated, except possibly burned to get rid of a heavy rough. Trees may also be planted in this manner in the bottom of furrows in soil that is not loose or not easily wind-blown.

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FIGURE 28.—Methods of planting slash pines: *A*, A scooter-plow furrow followed by two ordinary furrows on the sides affords a very good planting ground, especially in heavy broomsedge fields. The competition from weeds and grass is checked and the danger from fire greatly reduced. *B*, Group of agricultural high-school boys planting poor sandy land on the school farm with slash pine seedlings. The trees were planted with mattocks or spades 6 by 6 feet apart, making a stand of 1,210 per acre—a good spacing on small tracts of land such as about farms.

ana has set out more than 16,000 acres of slash pines at an average cost of about $4 per acre, including all expense items.

Where can slash pine be planted safely?

Within its natural range slash pine may safely be planted except in deep sterile sands and very wet lands.

Small plantings or plantations of a few acres each have been made in many places in eastern North Carolina, in South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and southeastern Texas, and some in western Tennessee. Figure 29 shows a representative farmer's plantation.

It has recently been observed that a rust canker (p. 50) is affecting the small seedlings in nursery beds and larger trees in the woods. This disease is most threatening in the western part of the natural range, including Mississippi and Louisiana. Slash pine may be extended by planting, apparently with a fair degree of safety, north of its range in South Carolina, Georgia, and eastern Alabama, but elsewhere it should be planted only on a very limited or experimental scale outside its range.

Large plantations of slash pine have been established in the deep South by farmers, lumbermen, large land-holding concerns, and one or more trunk-line railroads (fig. 30). The development of a large slash pine plantation and estimated returns are illustrated and described on pages 52 and 53.

The high cost of turpentining stands of widely scattered trees points clearly to a day when turpentining can be done profitably only in stands of good density or stocking. Planted stands promise to enter in a large way into the future production of naval stores. Already, planted stands are being very profitably worked for turpentine in southern Georgia and in Florida.

PROTECTION OF THE TREE CROP

Is woods burning harmful?

The damage and loss to slash pine caused by fire is enormous and ranks along with that caused by heavy and wasteful cupping. Both these causes of injury are man-made and of all the sources of injury can be most readily controlled.

The yearly burning of the woods, still practiced in some parts of the natural home of slash pine, has been done with little realization of the enormous damage to the timber and forest land and of the money loss to the owner.

If southern pinelands have seed trees and are protected from fire, young growth will generally spring up in sufficient abundance for a new crop. Young pines that are afforded protection from fire grow rapidly and create wealth. Protection of the cut-over lands from fires (fig. 31) would mean in a relatively short time the turning of millions of acres of idle lands into profitably growing crops of turpentine and timber.

Fire protection, although very desirable throughout the life of slash pine, is particularly so during the first 3 to 5 years of the life of seedlings. The rapid growth soon takes the sapling above the hottest fire zone, which occurs just above the dense grass. In this respect slash closely resembles loblolly pine but differs widely from longleaf pine. Although trees that have attained heights of 3 to 6 feet are

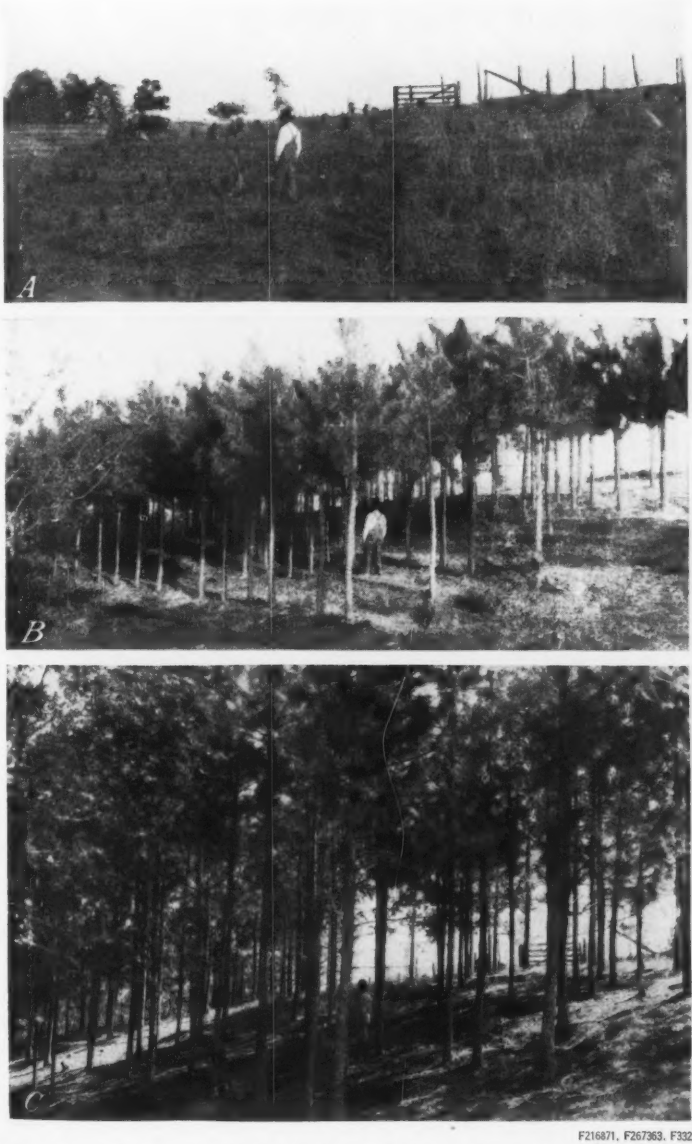

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FIGURE 29.—For 9 years this farmer hoped that pines would "take" this worn-out and idle hillside near his home in central Mississippi. Then he set slash pine seedlings, 8 by 8 feet apart, or 680 to the acre: *A*, Trees, 1 year after setting; *B*, same stand 5 years later; *C*, same stand 10 years after setting, age of trees, 12 years from seed. The farmer has cut and used fuel wood and sold pulpwood in thinning out the poorer trees.

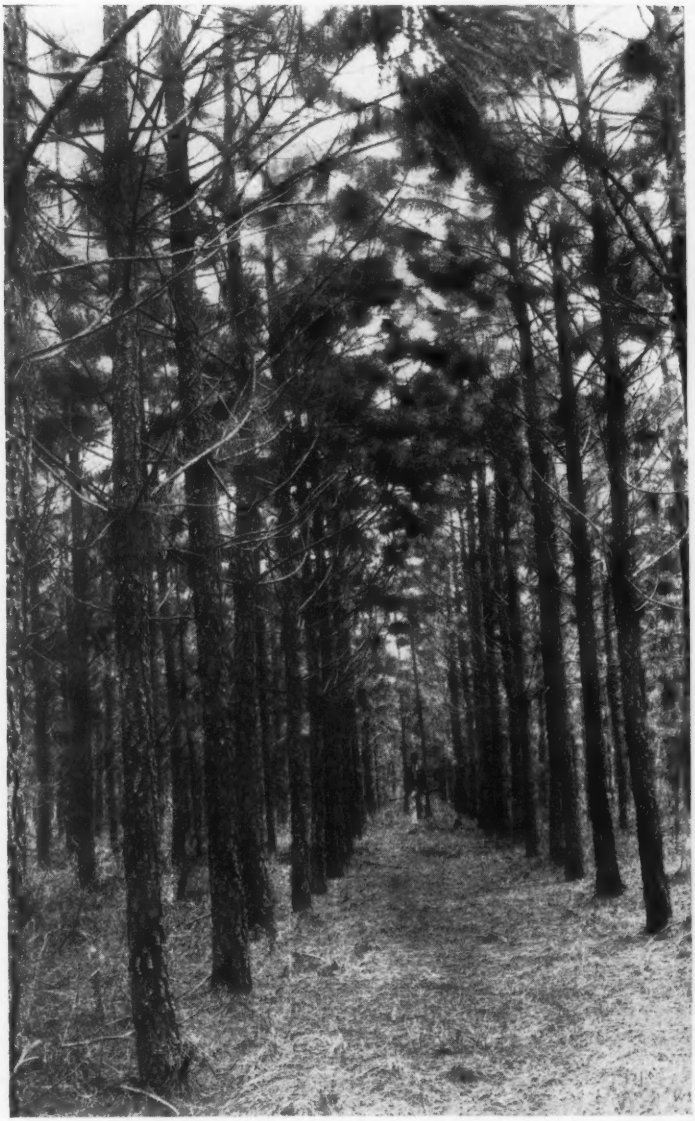

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FIGURE 30.—Slash pine 10 years after planting in a heavy broomsedge old field in South Carolina. The trees are 35 feet in height and 6 to 8 inches in diameter. Soon the trees 9 inches or over in diameter can be worked for turpentine. A second pruning can now be profitably made in order to produce clear, high-grade timber. (Forest owned and managed by a trunk-line railway.)

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FIGURE 31.—Fire is a serious menace to young pines: *A*, A fire burning at night was stopped by this woods road which is covered with carpet grass, closely grazed. All young trees on the left were killed. Across the road is a full stand of thrifty sapling slash pines. The practice of establishing carpet grass in firebreaks for grazing as a means of better protection is increasing. *B*, Two furrows thrown together make a cheap and effective firebreak in the wire-grass country for stopping a slow fire or for use in backfiring. A disk plow and tractor are used.

injured and sometimes destroyed by slow or "cool" fires, enough trees generally remain to produce a fair stand. Stands of pine which have not passed through repeated fires are fortunately becoming more numerous.

Fire damages and weakens mature trees, making them easy prey for insects and wood-rotting fungous diseases, or so-called punks. Trees weakened by fire are easily wind-thrown, and this causes the loss of large amounts of pine timber (fig. 15). Every year millions of young pine trees, the foundation of the future forest income, are killed by fire. Other millions of young saplings are defoliated and otherwise injured, and stunted in growth. The period of growth required to reach merchantable sizes is thus lengthened and the financial returns decreased.

Pine timber grows rapidly when the trees are given enough growing space and kept from harm by fire. (See pp. 8 and 12.)

What damage is caused by insects?

Outbreaks of the southern pine beetle occur occasionally, but nearly always during years of extreme drought or locally in places where little rain has fallen for 2 or 3 months of the growing season. It is important that close watch of pine stands be kept during unusually dry periods. The adult is a small dark-brown beetle. In the soft inner bark of the tree it lays eggs which hatch into grubs, often known as worms. These feed on the rich, living layer of inner bark and new wood, thus girdling the tree and causing its death. The life history of this insect is known, and information regarding measures for checking its depredations can be obtained from State entomologists, or from the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D. C.

The pine sawyer is a large beetle whose larva, a white grub, bores into the sapwood of dead or felled timber. Its activity may be checked by peeling and drying the timber or immersing it in water.

Young slash pine seedlings are only occasionally injured by the Nantucket tip moth, which attacks the tender young shoots in the early summer. It is rare to find the shoots killed by this or any other insect. If so attacked, the tree becomes somewhat deformed, and its rate of growth is slowed up. Most trees successfully outgrow the attack.

Are pine trees subject to diseases?

If uninjured by fire or other agencies, slash pine, until an advanced age, is not seriously affected by "red heart" or other fungous diseases. Wounds caused by fire admit the spores or "seeds" of fungi, but as a rule the vigorous young trees are able to combat them successfully. Probably the antiseptic qualities of the crude gum help in this matter. After the tree reaches an advanced age red heart is likely to become an enemy, sometimes eating away the heartwood and thus weakening the tree, as well as destroying the value of the affected wood. The best protection is to keep out all fires, and cut and utilize the trees as soon as they show the bumps, which are good indications of the presence of disease.

A rust canker disease[7] has been spreading over parts of the South infecting various species of pines. It causes an unnatural sprouting and deforming wounds on the stems, branches, and small trunks of

[7] *Cronartium fusiforme*, or another closely related rust canker.

trees. The other species of rust causes rounded nodules on the stems or trunks. The rust disease is showing up in some forest-nursery operations. It is threatening to become serious, and studies attempting to mitigate the disease are under way. The alternate host of the rust is known to be various species of oaks. These are being cleared off in the vicinity of large nurseries.

PROFITS FROM SLASH PINE STANDS

The financial returns from second-growth pine on the farm or small holding are not difficult to determine if fire, the chief source of damage and loss, is absent. Under fire prevention or control the

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FIGURE 32.—Slash pine ranks as the fastest-growing pine in the South up to about 20 years of age. On old fields its growth is often extremely fast. At 13 years of age this stand is being worked for turpentine with 104 trees per acre, bringing the owner $10.40 per acre. In addition there were 524 trees per acre left for future working. This stand represents about the maximum rate of growth and yield of products for the age.

lands naturally restock without expense, and the timber growth is rapid. A very favorable situation on many farms is that second-growth pine from 20 to 40 feet in height already occurs, sometimes covering a considerable part of the farm. If the timber is slash pine, it will be merchantable for turpentine, ties, pulpwood, and firewood at ages of from 20 to 30 years, yielding from 12 to 60 cords of wood per acre (fig. 32). Older stands, from 30 to 40 years of age, yield saw timber at the rate of 7,000 to 18,000 board feet per acre. Thus slash pine affords a choice of two sources of revenue. The value of young growth is being realized more and more as utilization includes smaller and smaller sizes of timber. Under these conditions, obviously, only a comparatively few years are required for rapid-growing kinds of trees to become merchantable.

LANDS RESTORED TO PRODUCTIVE USE

A large lumber company in southern Louisiana in the winter of 1924–25 planted slash pine seedlings on 1,000 acres of its cut-over land, part of about 30,000 acres that were planted. The land had been held for sale for many years, but no buyer had appeared. The planting cost was $4 per acre. The growing stand is shown in figures 33 and 34. When the trees were 12 years of age the owners cut 6 cords of pulpwood per acre, worth $1 per cord stumpage, and left 18 to 20 cords per

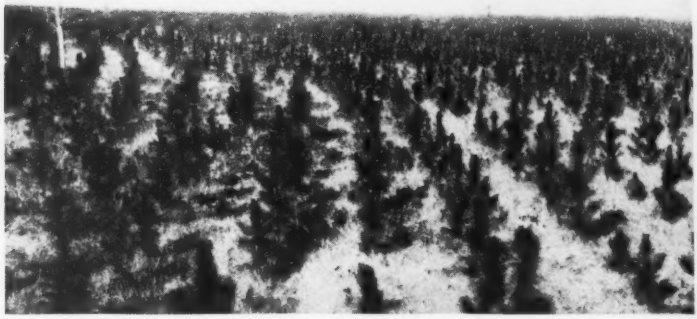

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FIGURE 33.—Slash pine seedlings were planted 8 by 8 feet apart, or 680 trees to an acre, on 1,000 acres of cut-over pineland in January and February 1925, by a lumber company in southern Louisiana. This picture shows the trees when 5 years old, at a height of 8 to 12 feet. (See also fig. 34.)

acre, as shown in figure 34*B*. The estimated later returns from timber up to the age of 30 years are summarized as follows:

TIMBER PRODUCTS

Original investment: Land, $3 per acre; cost of planting, $4 per acre; or a total investment of $7 per acre.

At the end of 12 years: Original investment carried at 4 percent and yearly taxes and protection at 15 cents brings the gross investment to a total of $13.45. Pulpwood sold ($6) reduces the net investment to $7.45.

End of 18 years (estimated): The net investment, carried at 4 percent, and a yearly carrying charge of 15 cents per acre, make the gross investment $10.41. Pulpwood to be sold ($6) reduces investment to $4.41 net.

At the end of 24 years (estimated): The net investment, carried at 4 percent, and yearly carrying charges of 15 cents per acre make a gross investment of $6.57. Pulpwood to be sold (6 cords at $1, or $6), and sawlogs to be sold (8,000 board feet at $5, or $40) makes a net profit of $39.43.

At the end of 30 years (estimated): Figuring the annual carrying charge of 15 cents per acre for protection against the sale of 10,000 board feet of sawlogs at $5 per thousand or $50, makes the total net profit $88.44 per acre from wood products.

TURPENTINE PRODUCTS

Working the trees for naval stores provides additional income. For this purpose it is assumed that 200 trees per acre (9 inches or over in diameter) will be worked for two 5-year periods, or 10 years, during the age period of 15 to 30 years. This will include cupping and back-cupping. At an estimated lease price of 4 cents per face per year an income of $80 will be derived.

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FIGURE 34.—Later views of the slash pine plantation, shown in figure 33: *A*, Two years later, or 7 years after planting; *B*, 6 years after the picture *A* was taken, or 13 years after planting. One year before picture *B* was taken 6 cords of pulpwood per acre were cut by taking out the least promising trees, leaving the straightest and fastest growing for later harvests of pulpwood and sawlogs. The large stumps are from the original logging of longleaf pines. Recent stumps are hidden in the grass.

TOTAL INCOME

Adding the return from turpentining to the profit from wood products gives a total of $168.44 per acre as the net income, or an average of approximately $5.60 per acre per year over the 30-year period.

TURPENTINE AND TIMBER RETURNS

Land of average quality that is well stocked with slash pine may be expected over a period of from 10 to 25 years to yield a net yearly income from crude gum of from $5 to $10 an acre. During this time, and especially following the working, the stand should yield a very considerable revenue from the sale of the timber for poles, sawlogs, pulpwood, cross ties, or fuel wood. This should materially increase the average yearly return.

Open-grown slash pine, on average situations, may be expected to produce in 40 years a merchantable log 40 feet long, measuring 10 inches at the top by 18 inches at the butt and containing 270 board feet of lumber.

Slash pine grows rapidly in dense stands and, at from 15 to 25 years of age, yields large amounts of crude turpentine. After liberal deductons for taxes and fire-protection costs during the period have been made, concrete examples of well-stocked stands of young growth show profits of from 8 to 12 percent compound interest on an investment of $5 an acre.

Crude gum, leased for working in the standing tree, has long been looked upon in the South as a standard farm product. In many sections of the South farmers are cupping their timber and selling the gum to the local stills. After trees reach 9 inches in diameter, cupping them for turpentine is extensively practiced. In closely grown slash pine stands this size corresponds to ages between 20 to 30 years on good soils and 35 to 50 years on unfavorable situations. Open-grown trees reach this size at ages of from 15 to 25 years. Many farmers and other small timber owners have derived a good profit from selling the turpentine rights to operators of stills for 4 to 6 cents per year for each face or cup for a period of 4 or 5 years' working. When carefully turpentined for a period of from 4 to 12 years or more, including resting intervals, and then turned into poles, piling, or lumber, slash pine can be handled on short rotation or at an early age with good profit.

The demand for timber to be used in making pulpwood, ties, poles, excelsior blocks, and stave wood indicates good markets hereafter for small-sized timber. New paper mills, each requiring from 100 to 500 cords of wood daily, are being established in the South in regions not already fully covered by similar mills. The pulpwood in many instances is drawn from locations 100 miles from the mill. Lumber of smaller and poorer grades is being used each year in increasing amounts, and the higher grades are relatively difficult to find and high-priced (fig. 35). These factors point toward the profitable growing of crops of slash pine with resulting benefit to the landowner, the community, and the State.

There is plenty of land on farms for growing timber as a crop after all the better lands are used for other farm crops and for pastures.

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FIGURE 35.—Slash pine in its virgin haunts. In the original forest, slash pine was confined to poorly drained flatlands, but since the cutting of the virgin forests it has spread widely over much of the region formerly dominated by longleaf pine.

No farmer can afford to pay taxes on idle land. Forest conservation on the farm has come to be a matter of economic necessity.

Forests, unlike many natural resources, can be used and regrown forever. Continuous production of tree crops on lands best suited for the purpose is the aim of forestry.

Since timber and wood are required for the successful operation of the farm and since most farmers have some lands best adapted to tree growth, the growing of timber as a crop is legitimately a part of the farm program.

FURTHER INFORMATION

The State foresters, most of whom are located at the various State capitals, and the State extension foresters of the various State colleges of agriculture are in a position to furnish further information regarding slash pine in their respective States. Farmers should consult their local agricultural county agents, who are now dealing with forest trees as a farm crop. These agents are in close touch with the State extension forester and have for distribution various publications on the subject of tree farming. Requests may also be addressed to the Office of Information, United States Department of Agriculture, Washington, D. C.

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Slash Pine

U.S. Department of Agriculture
Farmers' Bulletin No. 1256

XUM

SLASH PINE is a fast-growing southern pine and yields revenue in turpentine gum at an early age while it is growing timber.

Farmers and other owners of cut-over pinelands in the South Atlantic and Gulf regions are deriving a good profit from poorly drained and other lands by utilizing them for the production of turpentine and timber as well as for the grazing of livestock.

Well-stocked stands of slash pine on average land at ages of 15 to 25 years produce wood for pulpwood, stave blocks, fuel, etc., at the rate of one-half to 1 cord an acre a year, or sawlogs at the rate of 100 to 300 board feet an acre a year. On good-quality land well-stocked stands are growing at the rate of 1 to 2 cords, or 300 to 600 board feet, per acre yearly.

Slash pine can be profitably grown in the South on poor and wet lands, but it grows better on good land.

There are millions of acres of worn-out or unimproved parts of farms and cut-over lands that are profitless for other crops, but suitable for the production of timber and naval stores.

By proper methods of protection and cutting, southern pine forests can be perpetually renewed and kept continuously productive.

Young pine is valuable.

The picture on the title page shows second-growth slash pine in southern Georgia being worked for turpentine.

Washington, D. C.

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SLASH PINE

By WILBUR R. MATTOON, *senior forester, Forest Service*

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SLASH PINE—A DUAL-CROP TREE

SLASH PINE, a native of the South Atlantic and the Gulf region, is one of the most profitable forest trees in the United States.[1] In its own range it is being extensively cared for and planted in orchards because of its rapid growth and high value for the production of naval stores, pulpwood, and lumber.

Second-growth slash pine, following the cutting of the original forest, has spread rapidly over large areas of flatlands and low uplands of the region. It has been particularly aggressive in establishing itself on old fields and other idle or waste lands about farms and towns. A large percentage of the total amount of sap pine cut for all purposes in southern Georgia and northern Florida is slash pine. Timber from original-growth trees is used or sold without discrimination along with longleaf pine.

The wood of slash pine is straight-grained and suitable for a wide variety of uses. The width of the rings naturally depends on the rate of growth. The yield of crude turpentine from slash pine is the largest from any of our native trees. In the economic development now well under way in the South, slash pine is playing a large part in bringing lands not suited for other agricultural crops into their most profitable use.

A caution in managing slash pine lands cannot be too strongly emphasized. The custom of turpentining small trees before they reach the age of profitable working and ample seed production calls for special attention in management. There should in all cases be an

[1] The botanical name is *Pinus caribaea* Morelet. Formerly in forestry literature the tree was called Cuban pine.

The right use of the turpentine hack and later the ax and saw, and the protection of the land at all times from fire are the keys to the problem of growing slash pine profitably as a crop.

XUM

abundance of seed just before making the final cutting of the timber crop so as to provide for the renewal of the stand as the necessary basis for another timber crop on the land.

How can you tell slash from other pines?

Because of the general resemblance of young slash pine to vigorous loblolly pine, and of the mature slash pine to longleaf pine, considerable difficulty is experienced by persons unfamiliar with the southern pine forest in differentiating the species. However, slash pine is not difficult to identify if one possesses the essential information regarding the leaves, cones (burs), bark, and winter bud.

The bark (fig. 1) is fairly similar to that of longleaf pine. It differs from that of loblolly pine by being less deeply furrowed. Old mature slash pine may be readily told by its orange-colored bark plates or scales.

The leaves grow in clusters of two or three, usually with more of the two-leaved clusters. They are mostly 8 to 12 inches long, and bright, glossy rich green (fig. 2). The heavy, shiny green foliage helps greatly in distinguishing slash pine from the associated longleaf pine with its coarser and rather bluish-green foliage. Loblolly pine, like longleaf pine, has three bluish-green leaves in a cluster, but it has much smaller leaves than long leaf or slash.

The cones are egg shaped and average 3 to 4 inches in length and, when closed, are about 2 inches wide (fig. 2). A prickle is borne on the lustrous or varnished brown end of the cone scale.

The terminal bud is large, is reddish brown in color, and in the spring elongates into a straight, stout, light-gray "candle" about as thick as a large pencil. Longleaf pine, in distinction, has a similar but larger bud elongating into a light-gray candle an inch or more in diameter.

The main characteristics by which slash pine may be identified are the two-leaf or three-leaf clusters of long, dark-green leaves; the slender prickle on the cone, pointing straight or slightly curved upward on the lustrous-brown scale of the fresh mature cone; and the early-spring candle or shoot, which is light gray, erect, and about one-half inch in diameter.[2]

Mature trees of slash pine rise to heights of 80 to 125 feet, with clear lengths of 40 to 70 feet. Diameters of trunks range from 2 to 3 feet, measured at breast height, or 4½ feet from the ground.[3] Old-growth trees at maturity are mostly from 100 to 200 years old.

WHERE SLASH PINE GROWS

The natural range of slash pine extends from about Charleston, S. C., westward through the lower parts of Georgia, Alabama, Mississippi, and southeastern Louisiana to the Mississippi River (fig. 3) There are large areas of slash in Georgia and in Florida, where the tree grows nearly to the end of the peninsula. Slash pine is commercially important over its whole range.

In the original forest slash pine was confined mostly to the poorly drained flatlands and borders of swamps and bodies of fresh water. With the subsequent extensive cutting slash pine was released in much

[2] The spring shoot of loblolly is grayish green, slender, and often curved or drooping instead of erect.

[3] Unless otherwise stated, all diameters referred to throughout this bulletin are based on measurements at breast height.

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FIGURE 1.—A young generation of slash trees about 14 years old is shown with a mature tree. Light orange-colored scales or plates of bark serve to distinguish mature slash pines from other species of pines.

the same way as was loblolly pine farther north, and it is now spreading widely over lands formerly dominated by longleaf pine (fig. 4). It is found on many different kinds of land, but not on dry, deep sandy ridges. On wire grass and palmetto flats it is often the only second-growth species of pine. Slash pine thrives extensively over the low, rolling lands of the southern Coastal Plain, in sandy loam soils in poorly drained situations, and in the wet, mucky soils of bays,

FIGURE 2.—The cone or bur of slash pine is 3 to 4 inches long. The ends of the cone scales are plump, rounded, lustrous, and bear a small prickle. At the base of each scale are borne two seeds, each with an ample wing for wide dispersal. Leaf bundles of slash pine contain either two or three leaves.

ponds, and swamps. It will tolerate a highly acid condition in the surface soil, and a calcareous substratum does not appear to be unfavorable to its growth. On soils with hardpan at shallow depths the tree appears to be somewhat dwarfed in size. It is absent from the very dry, deep sands of the "pine-barren" hills, such as are found in parts of western Florida and southern Mississippi; but even in those sections it is locally abundant on wet flats and close to lakes and streams and in the numerous ponds scattered all over the Coastal Plain. By means of planting the range of slash pine is being considerably extended.

THE WOOD AND ITS USES

Slash pine averages the heaviest, hardest strongest of all the commercial conifer woods in the United States.[4] The weight of the air-

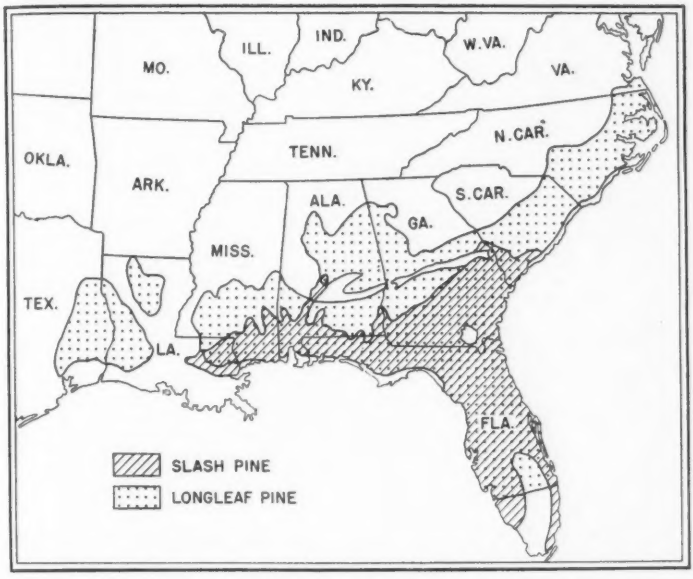

FIGURE 3.—Slash pine is found growing naturally in the region shaded by lines Longleaf pine is found in the region indicated by scattered dots. Both kinds of pine thus occur in the slash pine belt.

dry heartwood averages 45 pounds per cubic foot. In the butt cut the wood averages about 55 percent of dense bands of summerwood, while farther up the tree the proportion of summerwood decreases, at the top of the second cut to about 40 percent (fig. 5).

What are the chief uses of the wood?

The lumber from mature slash pine is used for structural purposes and is in demand for bridges, trestles, docks, warehouses, and factories, in which it is employed for dimension timbers, posts, piles, and joists. On account of its strength and stiffness, it is used for railroad cars, and its hardness and wearing qualities make it suitable for flooring. It is extensively used for veneers for boxes and other packages, and as boards for slash cooperage.

Second-growth or "sap" slash pines after being turpentined are extensively cut for use as cross ties and pulpwood.

The wood of slash pine is well adapted for making paper pulp, and the mills accept it (fig. 6) readily along with that of other kinds of pine. The wood is manufactured into kraft paper, which is the extensively used brown wrapping paper made in various thicknesses

[4] According to results of tests made at the Forest Products Laboratory, U. S. Forest Service, the wood of slash pine averages a little heavier, harder, and stronger than that of longleaf. Dept. of Agr. Tech. Bull. No. 479, Strength and Related Properties of Woods Grown in the United States.

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FIGURE 4.—Thrifty slash pine trees 22 years old. One group of the smaller trees has been worked for turpentine and cut out, leaving the larger trees to grow for other crops of turpentine and poles, piling, or saw timber.

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FIGURE 5.—The very dense or heavy wood of the slash pine, formed even during its early years, is a good characteristic of the tree. The 17-year-old tree shown in the section produced 63 percent dense summerwood, leaving only 37 percent soft springwood.

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FIGURE 6.—The use of southern pine for pulpwood is rapidly increasing. The pulp mills buy round or split wood from 4 to 12 inches in diameter. There is a much larger demand than formerly for slash and other pines for making paper.

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and shades of color. The paper industry is expanding rapidly throughout the pine region of the South. Analysis has shown a low percentage of resin in sapwood of cut trees. Slash pine is also used extensively for fuel. Because slash pine occurs in dense stands of straight clean trees, it is one of the choicest timbers for poles and piling, for which use it is cut in large quantity and brings good prices (fig. 7).

GROWTH OF TREES

Slash pine is one of the most rapid growing and earliest maturing of all our forest trees. Growth in height and in diameter is especially rapid during the younger stages up to about 20 years of age. One-year-old seedlings commonly reach 8 to 12 inches in height.

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FIGURE 7.—Slash pine trees grow in close or dense stands and after turpentining are cut in great numbers for telephone and power-line poles. Treated with creosote they will last for 20 to 40 years.

At 5 years, slash pines range mostly from 8 to 12 feet in height. During the next 5 to 10 years an upward growth of 2 to 3 feet yearly is not uncommon. When about 20 to 25 years of age the rate of upward growth slackens, apparently being about the same as that of longleaf on situations of similar grade. In crowded stands (fig. 8) the increase in diameter is slower than that of trees growing a considerable distance apart. Table 1 shows for different ages the average heights and diameters of slash pine trees and the number of trees per acre found in well-stocked stands. The range in size at any given age varies chiefly with the favorableness of the soil or situation and with the tree density, or number of trees per unit area.

How fast do slash pine trees grow?

For example, as shown in table 1,[5] at 15 years of age the trees in well-spaced stands range in height from 29 up to 48 feet, and in open-grown stands (columns 5, 6, and 7) in diameter from about 5 to more

[5] The tables of growth, volume, and yield of timber and much of the information on good turpentine practices are based upon the results of studies carried on by the Southern Forest Experiment Station of the Forest Service, located at New Orleans, La.

than 8½ inches. If, however, the trees have grown closely with less space for development, it is not uncommon to find them from about 4 to 6½ inches in diameter at breast height, as shown in columns 8, 9,

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FIGURE 8.—The adaptability of slash pine to heavy wet soils enables it to grow rapidly even in dense stands, thus producing a large amount of wood in a relatively short period. This stand should now be thinned for wood products and worked conservatively for turpentine. The latter operation can be continued for 20 to 30 years.

and 10. At 30 years slash pine stands usually consist of trees ranging from 48 to 79 feet in height, and in diameter in open stands from 8 to 13½ inches, or in crowded stands from 6 to 10½ inches. Crowded stands 30 years old may have about 300 trees per acre that measure 7 inches and more in diameter. Open, or better spaced stands for turpentining may have from 150 to 200 trees per acre.

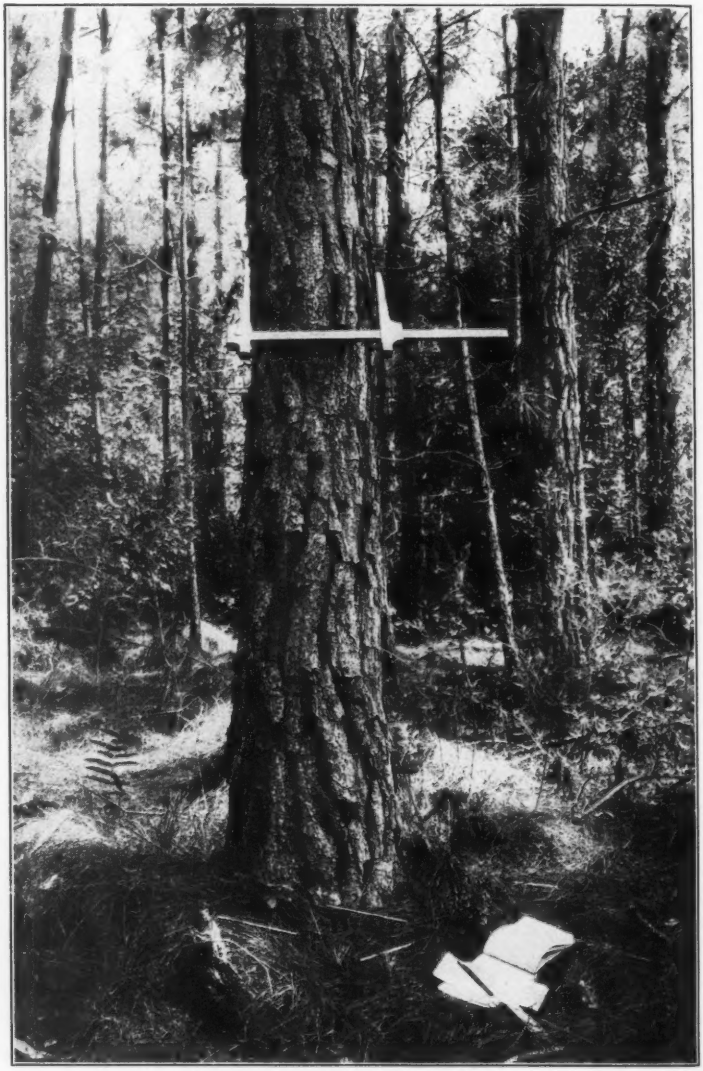

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FIGURE 9.—Example of fastest growth of slash pine resulting from continuous fire protection. The trees in this 17-year-old unburned stand were mostly from 8 to 13 inches in diameter and from 50 to 65 feet tall. The average tree was 10.7 inches in diameter (breast height) and 61 feet tall. In the 17 years this open-grown stand had produced 12,600 board feet of lumber. The thick mat of pine leaves or straw, plainly seen in the picture, affords favorable soil protection against extremes of heat and drought.

TABLE 1.—*Average size of slash pine trees at different ages grown in open and in close stands on different grades of soil; also average number of trees per acre*

Age of trees (years)	Height of trees on—			Diameter of trees (breast height)						Trees per acre in fully stocked timber stands [1]
				Open-grown stands on—			Close-grown stands on—			
	Good land	Average land	Poor land	Good land	Average land	Poor land	Good land	Average land	Poor land	
	Feet	*Feet*	*Feet*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Number*
15	48	39	29	8.8	6.9	5.2	6.6	5.2	3.9	55
20	61	48	36	10.3	8.0	5.9	7.7	6.0	4.4	150
25	71	56	42	12.3	9.6	7.1	9.2	7.2	5.3	265
30	79	63	48	13.7	10.8	7.9	10.5	8.3	6.1	300
35	86	69	52	15.2	12.0	9.0	11.7	9.2	6.9	305
40	92	73	55	16.6	13.1	9.9	12.8	10.1	7.6	295
45	96	77	58	17.1	13.5	10.1	13.7	10.8	8.1	280
50	100	80	60	18.1	14.2	10.7	14.5	11.4	8.6	260
55	103	83	62	18.8	14.8	11.0	15.0	11.8	9.0	245
60	106	85	64	19.4	15.2	11.6	15.5	12.2	9.3	230

[1] All trees 7 inches and over in diameter outside bark at breast height. The trees on the better qualities of land are fewer and larger in diameter; the number on the poorer lands is greater and the trees are smaller in diameter.

The sizes of trees growing in good grade of soil are shown in the columns headed "Good land." The class "Poor land" includes very wet or highly acid soils, on which, however, slash pines often seed freely, but the trees make only slow growth and reach relatively small sizes at maturity. The "Average land" class applies to the great bulk of lands on which slash pine is found growing.

An open stand growing in an old field in northeast Florida is shown in figure 9, where the average tree of the 17-year-old stand was nearly 11 inches in diameter and 61 feet tall. Fire protection had been afforded throughout the life of the stand, which undoubtedly accounts for the large size and thriftiness of the trees and the maximum timber yield of the stand. Such open-grown or orchard-like stands favor the early production of turpentine and merchantable sawlogs, but sacrifice a larger production per acre at a later date. However, moderately open-grown stands should be favored over too-dense stands.

Do tree trunks lengthen?

Yes, but only by new growth at the top. Once the side limbs are formed, or set, they remain in that same position throughout the life of the tree, or until they die and drop off. All limbs or branches from the main trunk reach to the heart or center of the tree.

THINNING PINE STANDS

What effect does thinning have upon growth?

As in a stand of corn or cotton, the trees in a full pine stand crowd upon each other, and the stronger trees gradually crowd out the weaker. Too few trees on an acre result in bushy tops and knotty lumber; too many trees mean a slowing up of individual growth. There is a right number, varying with the age and location, to obtain the best growth of the largest number of trees. Thinnings are made when it is necessary to reduce the number of trees so as to obtain the maximum growth for the kind of product desired.

How should thinnings be made?

There are two ways of thinning pine stands. The whole subject of thinning slash pine stands is closely related to the working of trees for turpentine.

A so-called low thinning, as shown graphically in figure 10, consists of cutting out the smaller, less vigorous, diseased, and unpromising trees. They may be worked first, but only if profitable. This method favors the largest and best trees and more nearly keeps the timber production at its capacity. Size and quality count much in the value of the timber.

A well-known principle is to wait until the trees to be removed have reached a usable size, so that the thinning may at least pay for itself. The material removed may be used for firewood, pulpwood, excelsior wood, or small saw timber. However, in actual practice with relatively cheap labor during slack periods, it is often good practice to thin overcrowded young pines before they reach usable size. An idea of the number of trees per acre in full timber stands at different ages can be obtained from the last column of table 1. For best production of turpentine these numbers should be reduced one-half to two-thirds. Closely related to this subject is the plan of thinning and turpentining found on page 24, which should be considered along with this discussion (fig. 11).

In a so-called high thinning, the larger trees are worked and cut, thus giving space for the smaller trees to expand. It is not an uncommon practice of owners to work and cut the largest trees, because they are the first to become merchantable. What happens then is that the formerly stunted trees recover and attain normal growth. This adjustment usually requires a number of years, during which there is a loss in the growing power of the land. Thinning by this method (of cutting out the largest trees) permits of a periodical money return every 5 years or so, a feature which appeals strongly to the farmer or other owner of timberland and is especially desirable when adapted to cutting timber, without turpentining it, for pulpwood, fuel wood, or other small-sized product.

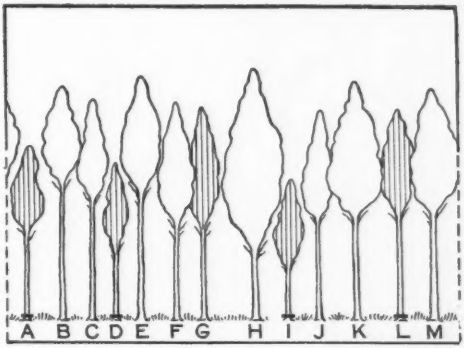
Pruning side branches makes clear trunks, desirable for turpentining and later for poles, piling, and saw timber. It may be started relatively early when the trees are 12 to 15 feet high. A good rule for young trees is to prune the lower half of the trunk and later the lower two-thirds. Too heavy pruning checks the tree's growth. Branches should be cut close to the main trunk in order not to leave a stub and even slightly wound the living layer (cambium) lying between the inner bark and the last layer of wood (fig. 11, *A*). An ordinary curved pruning saw has proved a good tool to use. A short ladder to reach the higher branches is also desirable.

TURPENTINING SLASH PINE

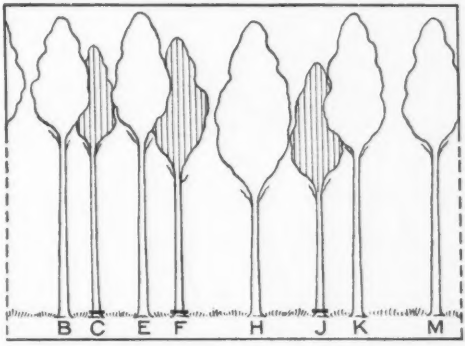
The growing of slash pine as a farm crop or, on a larger scale, as an agricultural industry centers largely about its capacity for producing naval stores as well as sap pine wood.

For every dollar of profit made from the wood of slash pine there is likely to be a return of not less than $2 from the crude gum (oleoresin). A too-common practice has been to work the trees as soon as they reached diameters from 6 to 8 inches, and after 3 to 4 years of working

Thinning.—Age of the trees, 5 to 10 years. A light thinning is to be made by cutting out the smaller, slower-growing trees, *A*, *D*, *G*, *I*, and *L*. This will still keep the bigger trees slightly crowded to force them to grow upward instead of growing outward and becoming bushy.



Thinning.—Age of trees, 15 to 20 years. Another thinning is to be made now of the smaller, less vigorous and less promising trees, *C*, *F*, and *J*.



Final cutting.—Age 30 to 40 years. The final cutting is made of all trees except one, *H*, a vigorous, bushy-topped tree, which is left to produce seed and restock the land. About three such trees are left growing on each acre until the land is well reset with young trees.

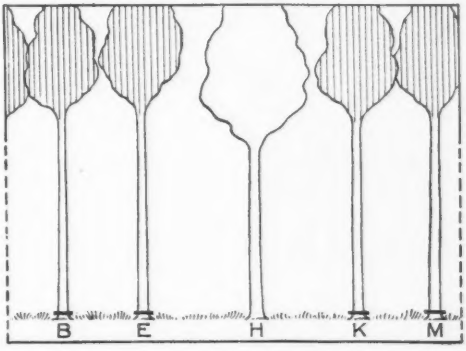


FIGURE 10.—A good method of working, thinning, and later cutting the final crop of pine trees where turpentine and timber products are desired at intervals. The smaller, less vigorous, and defective trees of this even-aged stand are worked and cut out, giving space for the stronger-growing trees to grow. This is repeated a few years later. The cuttings produce fuel wood, cross ties, small sawlogs, or pulpwood. The final cut produces saw timber or piling of good size, grade, and value. The trees to be cut are shaded. The letters aid in identifying the trees.

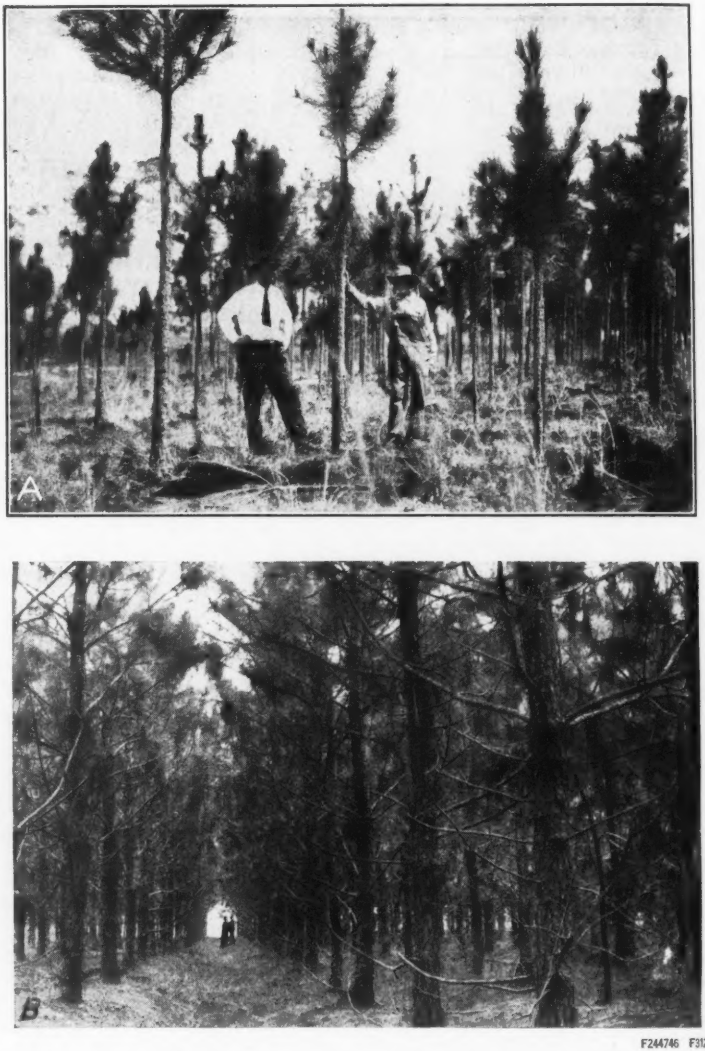


FIGURE 11.—Thinning and pruning young slash pine are desirable practices, favoring better growth and higher quality and value: *A*, This farmer (on right) during slack time in one winter thinned and pruned 86 acres of dense sapling slash pines. Stands of 900 to 2,000 saplings per acre were cut down to 150 to 300 trees. Both the pruning and thinning were somewhat too heavy, reducing the amount of growth. *B*, A very thrifty planted stand of slash pine 9 years old that should already have had two light prunings. The growth would not have been reduced, and the value of the stand would have been markedly increased.

to abandon the stand. Usually the trees have soon been greatly injured by fire, and in this manner second-growth trees have been extensively destroyed.

With the increase in the value of pine, practices of turpentining are improving. However, much pine timber is still being worked too small and too young, and the chipping is generally too deep and too wide up the tree. In order to keep pace with the keen competition that exists in the naval stores industry the successful turpentine man needs to use methods that will give him the greatest possible gum yields, keep down the costs, and maintain the vigor of his trees.

What are gum and naval stores?

When the sapwood of pine trees is wounded or chipped, it bleeds a thick sticky liquid known as crude gum (oleoresin). The gum is not, as is often supposed, the sap of the tree. It is not drained from a store in the tree but is formed in small cells or ducts scattered in the sapwood. When the tree is cut or wounded, these increase greatly in activity in order to heal over the wound. The heartwood is dead and, if cut, does not produce gum although it contains considerable hard resin.

It is well known in the South that this gum when heated in a still gives off a volatile liquid called spirits of turpentine, leaving a heavier thick residue which, upon cooling, solidifies to form rosin. In the days of wooden ships, turpentine and rosin and other products, known as naval stores, were made and extensively used in calking and waterproofing the hulls as well as in tarring the ropes.

How does slash pine rank in gum production?

Slash pine excels all other native pines in the quantity of gum which flows from the trees when chipped.

Its gum, when freshly exuded, is clear and about the color of light-yellow honey. As compared with longleaf or "hill" yellow pine, its nearest competitor, slash pine yields from its dip and scrape combined a slightly higher percentage of spirits of turpentine and a higher grade of rosin. In contrast to longleaf it produces only a little scrape. It is not uncommon to hear it said that slash pine is more likely to "dry face" and die from turpentining than is its associate, longleaf pine.

What are some good practices in turpentining?

Practices that are generally recognized to be advisable as a means of getting the most revenue out of timber, consistent with conditions of labor and market, include the following:

(1) Work no trees under 9 inches in diameter (at breast height measured outside the bark). Trees to be removed in thinning or improvement cutting may be considered as exceptions to this rule. The size of such trees that can be worked at a profit depends on the vigor or rate of growth and the density of the trees.

Only small yields, with rarely any profit, are obtained from trees less than 9 inches in diameter. Beginning with a 9-inch tree and working one low face at a time insures a high, sustained yield over a period of years and the largest profit in the long run to both owner and operator (fig. 12).

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Undersized trees in planted stands can often be worked profitably previous to thinning.

(2) Work only one face on trees from 9 to 14 inches in diameter, and never more than two faces at the same time on any tree.

(3) Advance streaks should be made preferably 4 to 6 weeks ahead of the regular chipping season.

(4) Use rust-free cups and gutters. Aprons or gutters should be attached with large-headed rustproof tacks, or they should be inserted in very light ax cuts. Do not slab off unnecessary amounts of bark and wood at the base of the tree. Careful hanging of cups and aprons or gutters prevents waste of gum.

(5) Use a No. 0 hack, as this permits cutting streaks one-half inch up the tree and three-fourths inch deep; this is known as medium-

F230970

FIGURE 12.—Good turpentining is shown. Only the larger trees, 10 inches in diameter or over, are being worked, with only one face per tree, and in 2 years the faces are only 32 inches in height. The cups were raised for the second year's working.

light chipping. Conservative methods of turpentining give a longer working life to the trees than heavy workings, which cause dry face and destroy more timber.

Low chipping, faces one-fourth to one-half inch in width, gives more gum than high (three-fourths inch) chipping over the lifetime of the tree. However, chipping one-half inch in height is best if the face is to be worked for 2 to 4 years or more. Low chipping is adapted for owners wishing to operate their timber continuously over a long period of years.

In practice depth of chipping ranges mostly from one-fourth to three-fourths of an inch (fig. 13). The yield of gum at the time increases considerably with an increase in the depth of chipping. Fast-growing slash pine can be chipped three-fourths of an inch deep for 4 or 5 years. Deep chipping in slow-growing timber results in exces-

sive dry face. Also deep chipping weakens the tree mechanically, making it more likely to be windthrown.

(6) Hang the cups as low as possible when the trees are first worked to prolong the working life of faces.

(7) Chip not more than one-third the circumference of the tree for a single face.

(8) Leave at least 4 inches of living wood for bars between the faces on all trees.

FIGURE 13.—Cupping trees for gum: *A*, Chipping a streak on a face is good turpentining practice. The cup is hung low, the tins are inserted lightly, and the streaks are shallow. *B*, Veteran slash pine tree which has been worked for more than a quarter century, first by the old boxing method on the front and the back faces. These have nearly grown over, and now active turpentining is under way on the new wood.

(9) If the crop is not well protected from fire, following the season's working, rake the ground clean for a distance of 2½ feet on all sides from the base of each worked tree (fig. 14).

More and more working is being done under fire protection on rough land. This eliminates the expense of raking and burning.

What are some bad turpentining practices?

Unprofitable practices of working timber include: (1) Working too small trees (figs. 15 and 16), (2) chipping too deeply and too wide, (3) placing too many faces on trees, and (4) leaving insufficient width in bars between faces.

It is difficult for private owners and operators to break away from the custom of cupping very small trees and over cupping large ones. In their desire for immediate returns they sacrifice heavily in income, or "kill the goose that lays the golden egg." A case is known in which

slash pine trees were cupped when 8 years old and the same trees backcupped 7 years later. Frequently all trees are cupped down to 6 or 7 inches in diameter, 2 cups hung on trees down to 9 or 10 inches, and 3 cups hung on trees 13 inches and over by laborers who are paid on the basis of each 1,000 cups hung, or of each crop of 10,000 cups. Heavy working is wasteful practice, except for the purpose of clearing up land or thinning heavy stands.

The flow of gum appears to be generally in proportion to the size and vigor of the trees and the size of the face up to the point where the tree is faced too severely. Practical men in the turpentine industry repeatedly express the opinion that a large percentage of the smaller-sized trees now bled are too small to pay for the cost of operation. The almost complete loss by wind and fire of small trees during or after severe turpentine operations is another important economic reason for adopting conservative methods.

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FIGURE 14.—If the crop is in much danger of burning, at the close of the season each tree is raked in order to give protection. Unburned land makes thriftier trees which yield more gum. Many operators are beginning to work their trees in rough, or unburned land.

YIELD OF GUM

How much gum and naval stores will a slash pine tree yield?

A slash pine tree, growing in an open stand worked with 32 streaks during the season and scraped, will yield as follows: If 9 inches in diameter (breast height), about 123 ounces; 10 inches, about 140 ounces; and 12 inches, about 180 ounces. Compare with these figures the yields of trees smaller than 9 inches, namely, 95 ounces from 8-inch trees and 80 ounces from 7-inch trees. In crowded or dense stands small trees run about one-quarter less for 9-inch trees and one-half less for 7-inch trees.

In units of naval stores the yield of slash pine trees may be illustrated by the average 9-inch tree, which produces a little under 8 pounds (123 ounces) of gum, which will make about one-fifth of a gallon of spirits of turpentine and about 5 pounds of rosin. A 12-inch tree will yield 11.2 pounds of gum, which will make about one-third of a gallon of spirits of turpentine and about 7 pounds of rosin.

How much naval stores will a crop of slash pine yield in a season?

There are 10,000 cups in a crop. Varying widely with conditions of size and vigor of trees, as well as the locality and the season, a crop of cups will yield in a full season from 100 to 400 barrels of gum. One dip barrel (50 gallons) of gum commonly yields from 10 to 11 gallons of spirits of turpentine; or it requires nearly 5 barrels of gum

to produce 1 barrel (50 gallons) of spirits of turpentine. The size of the tree is an important factor. A crop of average open-grown trees, worked for 5 years with 32 streaks per year, chipped one-half inch

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FIGURE 15.—Bad turpentining is shown. All the trees, including those of all diameters down to 5 inches, are being worked. The faces are deep, and the aprons have been driven deep into the trees. This causes low production of gum and heavy losses of timber.

deep by one-half inch high, with one face per tree should yield about as follows for different-sized trees: A crop of 9-inch trees should produce about 42 barrels of spirits of turpentine; 10-inch trees, 49 barrels; 11-inch trees, 55 barrels; and 12-inch trees, 62 barrels. With these trees of regulation sizes, may be compared the amounts of

naval stores yielded by crops of undersized trees; namely, 8-inch trees averaging 36 barrels and 7-inch trees averaging only 31 barrels.

The amount of rosin produced at the same time is about 3⅓ barrels to 1 barrel of spirits of turpentine. For example, a 50-barrel yield of turpentine at the ratio of 1 to 3⅓ means a production of about 167 barrels of rosin. The foregoing indicates the reason why working small trees does not pay expenses.

Trees grown in dense stands yield about one-quarter less gum for 9-inch trees, one-sixth less for 12-inch, and one-third less for 7-inch trees.

F230217

FIGURE 16.—Deep chipping and the inserting of aprons often result in serious loss of timber and money returns. Such loss as this by wind and also dry facing are, fortunately, less common now than in the past.

What are some important factors about turpentining and naval stores?

A barrel or cask of spirits of turpentine contains 50 gallons. A gallon weighs about 7¼ pounds.

A barrel of rosin weighs about 500 pounds gross but contains about 420 pounds net of rosin.

About 20 percent of the weight of the gum or dip from the cups is spirits of turpentine. An average of about 9 percent by weight of the scrape is spirits of turpentine, although there is a wide variation.

The scrape from slash pine trees is relatively small in amount. It is about 6 percent by weight of the total gum yield of the tree (dip and scrape). In contrast, the scrape from longleaf pine trees, if the cups are raised each year after the first, comprises about 24 percent of their total product. Otherwise the scrape is relatively larger in amount.

About 40 pounds of dip is required to yield 1 gallon of spirits of turpentine, or about 5 barrels of dip (400 pounds of dip per barrel) to yield 1 barrel of spirits of turpentine. For each barrel of spirits there is produced on an average for the season's run about 3⅓ barrels of rosin.

Advanced streaks are of much value in producing larger yields of gum during the early chipping season. The time recommended to make advance streaks is 4 to 6 weeks ahead of the first regular streak.

Low chipping (that which removes from one-quarter to one-half inch in height by each streak) for a season or two may result in less gum, but if it is continued for the entire working life of the face it will result in a larger yield of gum than high chipping. Medium chipping of about one-half to three-quarters of an inch in depth gives the best results in slash pine (fig. 17). Deeper chipping, although for a time giving a higher gum yield, results in greater injury by dry face and by windfall.

FIGURE 17.—A stand of slash pine that is being progressively worked. The larger trees that have been worked with one face for 5 years have just been back-cupped. The small worked-out trees have been cut into pulpwood or fuel wood.

The flow of gum depends closely upon the weather. A hot spell and likewise a hot, rather dry season will increase the flow of gum.

The larger the tree the larger the total yield of gum, other conditions being practically alike. Trees measuring under 9 inches in diameter (at 4½ feet above the ground) are doubtful money makers.

The largest total production of gum from a tree is obtained by working only one face at a time, chipping low and moderately deep, and nailing instead of driving the tins. Deep driving of the tins weakens the tree, causes more windthrows, increases dry face, invites insect attack, and decreases gum yields. When two faces are worked at the same time on trees up to 12 inches in diameter the total yield is only about 70 percent as much as that obtained by working only one face at a time. Experiments indicate that not more than one face should be currently worked on any tree which is less than 14 inches in diameter.

On the national forests in Florida turpentining rights have been leased for many years to individuals or companies under the terms of a carefully drawn contract sale. This also is being started on some of the more recently created national forests in the South. Sample copies of the form used will be mailed upon application to the regional forester, United States Forest Service, Atlanta, Ga.

The Department of Agriculture has a number of publications dealing in detail with various phases of turpentining. Application should be made to the Office of Information, United States Department of Agriculture Washington, D. C.

EFFECTS OF TURPENTINING AND FIRE

Does turpentining affect the growth of a tree?

The rate of growth is greatly checked by heavy cupping. One face per tree generally checks the growth of slash pine from one-fourth to one-third of the usual rate; two or more faces, one-half or more. Following the working of the tree, a gradual recovery in rate of growth and a natural healing over of the face take place, faster in the more vigorous and healthy topped trees.

Along with the injury from wounding and attendant loss of gum, it appears certain that exposure to uncontrolled fires and the injurious agencies of rot and insect infestation subsequent to turpentining have much to do with any decline in growth that may occur. It follows that slash pine, if properly handled, may be turpentined to advantage in advance of the final working and harvesting of lumber.

Does burning affect the yield of gum?

Since the yield of gum depends much upon the vigor of the tree, full protection against heavy burning is very profitable. The burning off of the leaves or needles or straw results in reduction of gum flow until they have grown back fully (fig. 18). By killing living limbs fire causes a continuous reduction in the gum yield. Burning off most of the foliage on young timber being worked for gum is known to have reduced the yield to one-half that on adjacent unburned trees. (See also p. 46.)

TURPENTINE MANAGEMENT PLAN

In simple terms, the problem of managing a stand of slash pine has as its main object obtaining the largest amount of gum and then cutting the trees for pulpwood, lumber, or other product; pine wood is coming to have an increasing use and value for pulpwood (fig. 19).

What are the important steps in handling slash pine as a dual crop?

A stand of young slash pines may be regarded as safe from ordinary ground fires when the trees are from 10 to 20 feet in height. Such trees will be from 6 to 12 years old. At this stage the stand may be thinned out so as to save from 200 to 300 per acre of the best trees, evenly spaced.

When the trees have reached heights of 50 to 60 feet, with diameters ranging from 9 to 10 inches, turpentining operations may be begun on all the trees except about 100 of the best-developed and thriftiest trees left as evenly spaced as possible to form the final timber crop. The trees may be worked for 3 years, rested a year, and back-cupped for the next 3 years—making a work period of 7

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FIGURE 18.—Fire reduces the ability of the tree to produce gum. If the tops or leaves are burned off it is advisable to rest the tree for at least 1 year. Badly burned trees may not recover for several years.

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FIGURE 19.—Chipping and dipping crude gum in a stand of slash pine.

years (fig. 20). The worked trees may then be cut and utilized for one product or another. The age of the remaining 100 trees will be from 25 to 40 years.

Slash pine trees or stands, when protected and rightly handled with rest period, can be worked for turpentine from the ages of about 15 to 40 years, or longer. A well-stocked stand will average a growth of 1 to 2 cords of wood per acre per year during the period of from 10 to 40 years, or an equivalent of 300 to 800 board feet per acre yearly.

This brings the owner to the last stage of management with an option of two courses, either of which may be adopted. The trees may all be worked as they grow, conservatively, one face at a time, for a period of 6 to 20 years. If the alternative method is adopted, the trees are allowed to grow to a good size for lumber, say 15 to 18

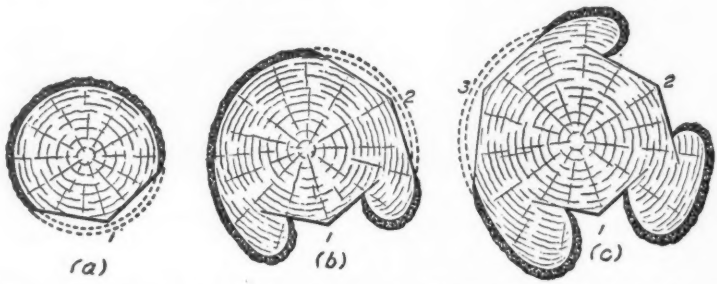


FIGURE 20.—The first working was begun when the tree (*a*) reached 10 inches in diameter (breast height). The second (*b*) was begun after a 3-year working and 3 years of rest; and the third (*c*) after similar periods of working and rest. Thus, the tree was worked 9 years during a period of 15 years. This method is one of very conservative working, resulting in a good growth of timber and high yield of gum. (The figures 1, 2, and 3 serve to identify the three faces).

inches, when they are worked heavily with two or more faces per tree for 3 or 7 years; in the latter case a year's rest is included. If the market is good, one or two high workings may be added.

The time required to grow the crop or the rotation period as here outlined will vary from 35 to 50 years, depending mostly upon the conditions of growth and market for naval stores and timber.

The exclusion of fire during the life of the stand and the one or more openings of the stand due to cutting the worked trees should result in a good restocking of the land to young pines. In the event, however, of failure to have a sufficient stand of young growth at the time for the final cutting of the mature tree crop, it would be necessary to make some special provision. One good way would be to arrange for the cutting during the late fall or winter following the scattering of a full crop of seed or mast.

LEASING TIMBER FOR TURPENTINE

The right to work trees for turpentine, often called a lease, is sold by timber owners to operators. The time is generally from 3 to 5 years, and the prices vary, depending upon the market and the size and location of the trees. Prices generally run from 3 to 5 cents per face per year, which for a 4-year lease would range from 12 to

20 cents per face. If the timber is leased on a percentage basis, the operator usually pays the timber owner from 15 to 25 percent of the local value of the turpentine and rosin produced.

Turpentine Leasing Agreement for Farmers

In leasing out turpentine rights to timber it will pay the owner well to do it under a written and signed agreement. Such a contract, in fact, will safeguard the interests of both parties. The essentials of such an agreement, as embodied in the following sample lease applicable to the use of small owners, are based upon one used by the United States Forest Service in leasing its timber on the national forests. Such money items as the rental charge per face and others which vary locally and from year to year are inserted here merely as illustrations to make the form as clear as possible.

Naval Stores Agreement

I, John Doe, of Pine City, State of Florida, hereby agree to work for naval stores certain timber on the lands owned by Richard Roe, Leesville, Fla. Said timber is all the slash and longleaf pine timber not excepted under the terms of this agreement located on an area of about 40 acres to be definitely designated by Richard Roe before cupping begins in section 9, township 4 north, range 6 east, Tallahassee meridian and base line, upon which it is estimated that 2,000 cups, more or less, may be placed. In consideration of the granting of this privilege to me for a term of 4 years I do hereby promise to pay to Richard Roe the sum of $400, more or less, as may be determined by actual count, at the rate of $200 per thousand cups, payable on or before March 15, 1939.

And I further promise and agree to work said timber in strict accordance with the following conditions:

(1) No tree will be cupped, chipped, raked, or worked in any manner until payment has been made in accordance with the terms of this agreement.

(2) Title to the product of the timber included in this agreement will remain in Richard Roe until it has been paid for as herein prescribed and removed from the tree.

(3) No timber will be cupped except that on the area designated by Richard Roe, and all timber on that area will be cupped except as herein specified.

(4) No marked tree and no tree 9 inches or less in diameter at a point 4½ feet above the ground will be cupped; not more than one cup will be placed on trees from 9 inches to 14 inches, inclusive, in diameter at breast height; not more than two cups will be placed on trees from 14 inches to 22 inches, inclusive, in diameter; and not more than three cups will be placed on any tree.

(5) The greatest depth of streaks will not exceed five-eighths of an inch at any point, excluding the bark. The width of the streaks will be so regulated that not more than three-eighths of an inch of new wood will be taken off at each chipping. The faces chipped or pulled the first season will not exceed 15 inches in height from the shoulder of the first streak of the season to the shoulder of the last streak of the season, including both. The faces chipped or pulled in subsequent seasons will not exceed 16, 15, 14, and 13 inches in height, respectively, for the second, third, fourth and fifth seasons, measured in the same way. A No. 0 hack or puller will be used for chipping or pulling. Bars or strips of bark not less than 4 inches wide in the narrowest place will be left between faces, and this width shall not be lessened as the faces progress up the tree. Where more than one face is placed on a tree, one bar between them will not exceed 8 inches in width. The first streak at the base of the face will be made at the time the apron or gutter is placed. Not more than one streak will be placed on any face during any week. Faces not chipped in accordance with these specifications may be marked out and the cups removed by Richard Roe.

(6) A cupping system satisfactory to Richard Roe will be used, and the cups and aprons or gutters will be so placed that the shoulders of the first streak will be not more than 6 inches distant from the top of the cup, and the cups first placed will be as near the ground as possible. No wood will be exposed on any tree by removing the bark below the gutter or aprons.

(7) No unnecessary damage will be done to cupped trees, marked trees, or to trees below the diameter limit. Trees that are badly damaged during the life of this agreement, when such damage is due to carelessness or negligence, shall be paid for at the rate of $6 per thousand feet board measure, full scale. Trees split or windthrown because of deep incisions for raised tins will be considered as being damaged unnecessarily.

(8) No cups will be placed later than May 15, 1939, without written permission from Richard Roe, and all timber embraced in this agreement will be cupped before said date. The cupping will proceed with all reasonable speed.

(9) Unless extension of time is granted, all timber will be chipped, dipped, and scraped, the product and all cups, aprons, gutters, and nails removed, and each cupped tree thoroughly raked to the satisfaction of Richard Roe not later than December 31, 1942. Tins will be pulled out, not chopped out.

(10) No fires will be set to the timber, underbrush, or grass on the area covered by this agreement without the written permission of Richard Roe, and during the time that this agreement remains in force I will, independently, do all in my power to prevent and suppress unauthorized forest fires on the said area and in its vicinity and will require my employees and contractors to do likewise.

(11) All cupped trees will be raked in a workmanlike manner for the space of 2½ feet around each tree during December of each year of the life of this agreement; and, if required by Richard Roe a fire line not less than 3 feet wide in the narrowest place shall be hoed or plowed around the area covered by this agreement in such a manner as to completely isolate it from adjoining lands. Natural firebreaks, such as creeks, swamps, roads, etc., may be utilized with the consent of Richard Roe. These fire lines must be made and receive the approval of Richard Roe before any cups are placed the first year or new streaks made at the beginning of each subsequent year.

(12) Richard Roe reserves the right to sell or otherwise dispose of and remove or have removed all dead timber and uncupped living timber from the area covered by, and during the life of, this agreement; provided, that the removal of such material will not interfere with the operations of the purchaser.

This agreement will not be assigned in whole or in part without the written approval of Richard Roe.

The conditions of the sale are completely set forth in this agreement, and none of its terms can be varied or modified except in writing with the approval of both parties.

And as a further guarantee of a faithful performance of the conditions of this agreement, I deliver herewith a bond in the sum of $500, and do further agree that all moneys paid under this agreement will, upon failure on my part to fulfill all and singular the conditions and requirements herein set forth, or made a part hereof, be retained by Richard Roe to be applied as far as may be to the satisfaction of my obligations assumed hereunder.

Signed in duplicate this 20th day of November 1938.

JOHN DOE,
(Signature of purchaser.)
Operator.
(Title.)

Witnesses (corporate seal, if corporation).
JOHN JONES.
TOM BROWN.

SCALING LOGS AND ESTIMATING TREES

What is a log scale rule?

A scale or rule which shows how many board feet can be cut from logs of various sizes. Most commonly, the diameter of the log in inches is measured inside the bark at the small end, and the length in feet over all.

Does it make any difference what log rule is used for measuring and selling logs?

Yes; a great difference both in the amount of timber and in the resulting money return.

The Doyle rule, although in common use in the South, is unfair to the seller for logs below about 28 inches in diameter. In the early days of large and cheap virgin timber, when narrow and knotty boards were worthless, it was fairly satisfactory, but for scaling small-sized timber, such as second-growth southern pine, it gives such small volumes for small logs as to make it unsatisfactory. On the national forests the Scribner rule (in the decimal C form) is standard. It is more fair than the Doyle rule for small logs, but reasonably careful sawing should result in obtaining from 10 to 20 percent more lumber than even this rule gives for second-growth timber.

TABLE 2.—*The contents of logs, in board feet, scaled by the International log rule, (using saw cutting ¼-inch kerf)*

Diameter at top end of log, inside bark (inches)	Contents (in board feet) of logs having a length of—						
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet
6	10	10	15	15	20	25	25
7	10	15	20	25	30	35	40
8	15	20	25	35	40	45	50
9	20	30	35	45	50	60	70
10	30	35	45	55	65	75	85
11	35	45	55	70	80	95	105
12	45	55	70	85	95	110	125
13	55	70	85	100	115	135	150
14	65	80	100	115	135	155	175
15	75	95	115	135	155	180	205
16	85	110	130	155	180	205	235
17	95	125	150	175	205	235	265
18	110	140	170	200	230	265	300
19	125	135	190	225	260	295	335
20	135	175	210	250	290	330	370
21	150	195	235	280	320	365	410
22	170	215	260	305	355	405	455
23	185	235	285	335	390	440	495
24	205	255	310	370	425	485	540
25	220	280	340	400	460	525	590

For small timber, such as second-growth pine, the International log rule (table 2) gives log volumes which are very close to what can be sawed out by using good methods. Careless sawing will give a lower volume of square-edged boards than the logs scaled by this rule, so that it gives the millman a chance to test his own efficiency in this respect. Producers of small logs will benefit when this or some equally close rule has come into general use. The sale of logs by the International rule is recommended.

As a comparison, a log measuring 10 inches in diameter inside the bark at the small end and 16 feet long, when carefully sawed with a circular saw of ordinary thickness (¼-inch kerf) should, according to the International rule, turn out 65 board feet. For the same log the Doyle rule (table 3) would show 36 board feet, or only about one-half the amount that can be actually sawed and that is credited to it by the International rule.

TABLE 3.—*Contents of logs scaled by the Doyle log rule*

Diameter at top end of log inside bark (inches)	Contents of logs having a length of—						
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
6	2	2	3	3	4	4	5
7	4	5	7	8	9	10	11
8	8	10	12	14	16	18	20
9	12	16	19	22	25	28	31
10	18	22	27	31	36	40	45
11	24	31	37	43	49	55	61
12	32	40	48	56	64	72	80
13	40	51	61	71	81	91	101
14	50	62	75	87	100	112	125
15	60	76	91	106	121	136	151
16	72	90	108	126	144	162	180
17	84	106	127	148	169	190	211
18	98	122	147	171	196	220	245
19	112	141	169	197	225	253	281
20	128	160	192	224	256	288	320
21	144	181	217	253	289	325	361
22	162	202	243	283	324	364	405
23	180	226	271	316	361	406	451
24	200	250	300	350	400	450	500

How are logs scaled?

The diameter of the small end of the log inside the bark is measured in inches, and its length is taken in feet. If a scale stick is used, the contents of the log are read directly from the stick. These readings are for straight and sound logs. Thus the scaling of sound and straight logs is a simple matter. Experience and special knowledge are required to determine the allowance that should be made for defective logs. Slash pine logs average high in freedom from rot.[6]

How many board feet of saw timber can be cut from logs and slash pine trees of various sizes?

Much depends on the degree of care exercised, the kind of saw used, and the amounts taken from, and left in, the woods. The International rule (table 2) shows how many board feet of lumber can be sawed from straight and sound logs of different sizes with a circular saw cutting a ⅛-inch kerf, all the usable lumber being taken. This rule shows not what is being cut by wasteful methods but what can be sawed out to meet the present conditions of good utilization. A deduction should be made for crook and defect.

To estimate the board-foot contents of a tree, the diameter in inches outside the bark (at breast height, or 4½ feet above the ground) and either the number of 16-foot logs or the total height of the tree should be ascertained. For example, as shown in table 4, the contents of a 14-inch tree having three 16-foot cuts is 129 board feet, or if the tree is 70 feet in height it contains 146.6 board feet. Or, if the total height of the tree and the breast-high diameter (outside the bark) are known, the contents can be estimated by referring to table 4, likewise based upon the International log rule. For example, a slash pine 16 inches in diameter and 70 feet in total height will cut out about 186 board feet, if each log is straight and sound.

[6] For more information regarding how to scale logs and estimate standing timber, consult Farmer's Bulletin 1210, Measuring and Marketing Farm Timber.

TABLE 4.—*Saw timber contained in slash pine trees of (1) various diameters and number of 16-foot logs in tree, and (2) various diameters and total height of tree*

Diameter of tree outside bark at breast height (inches)	Contents of trees[1] having—											
	Specified number of 16-foot logs					A total height of—						
	1	2	3	4	5	40 feet	50 feet	60 feet	70 feet	80 feet	90 feet	100 feet
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
7	18	27	42	------	------	9.05	12.67	17.20	23.53	30.77	------	------
8	20	34	52	------	------	14.48	20.82	28.96	38.01	47.97	------	------
9	23	39	63	88	------	21.72	30.77	41.63	53.40	66.97	------	------
10	25	44	76	106	139	27.15	41.63	55.20	69.68	88.69	104.98	123.04
11	------	51	88	125	166	------	------	69	88	110	131	156
12	------	57	101	146	192	------	------	84	107	133	159	186
13	------	62	115	170	221	------	------	100	127	157	187	221
14	------	70	129	187	250	------	------	116	147	180	216	253
15	------	76	143	211	282	------	------	131	167	205	246	290
16	------	83	160	234	314	------	------	148	186	229	274	344
17	------	------	177	261	348	------	------	163	205	253	304	362
18	------	------	193	287	384	------	------	179	226	278	333	396
19	------	------	212	315	422	------	------	195	246	302	362	431
20	------	------	231	345	463	------	------	212	266	327	391	465

[1] By the International log rule. Circular saw, ¼-inch kerf. Full scale for straight and sound logs. Make deduction for crook and defect in trees. For contents of trees using band-saw (⅛-inch kerf) add 12 percent.

How many slash pine trees will be required to make a cord of wood?

That depends on the size of the tree or trees. If one knows what fraction of a cord of wood is contained in trees of different specified sizes, then he can easily get the desired number of trees. Table 5 gives the fraction of a standard cord (a stack of wood 4 by 4 by 8 feet) which different-sized trees contain when worked up in usual sizes of 4-foot wood with the bark. For example, a tree 12 inches in diameter (at breast height) and 60 feet in total height, if of normal or average shape, when worked up into cordwood with the bark on, contains about 0.218 cord. This is slightly over one-fifth of a cord, or five trees of this size will make a little over a standard cord.

Or, figuring in another way, a 10-inch tree 50 feet in height contains about 0.12 cord; therefore, eight such trees would cut up into about a cord. Or, four 13-inch trees 60 feet in height would make a cord, since one tree contains one-fourth of a cord.

A person can thus measure the trees that should be thinned out for pulpwood or fuel wood, tally them by diameter and heights, and quickly calculate about how many cords they will make.

Various kinds of tree-scale sticks, or cruising sticks, are coming into use in measuring the diameter and the height, or the number of logs, in a tree. Some of the sticks also show for trees of different diameters and number of 16-foot cuts, the number of board feet of saw timber that can be cut out. Information as to sources of tree-scale and log-scale sticks and their use can be obtained from State forestry departments, the extension services of State colleges of agriculture, or the Forest Service, United States Department of Agriculture.

TIMBER PRODUCTION PER ACRE

Many stands of slash pine of known ages have been studied and measured to find out how much timber they will yield per acre. In this the forester deals with fully stocked stands, or those which have no blanks or spots without trees. The quantity of timber is measured

in the standing trees, either in cords, cross ties, or lumber. With the figures so obtained it is possible to predict the rate of growth and the quantity of timber there should be on an acre at different ages.

How many cords of wood will an acre of slash pine produce?

A fully stocked stand of slash pine 20 years old on poor land should cut out per acre about 20 cords of wood (with the bark on); on average land about 35 cords, and on good land about 46 cords (table 5). The average growth of fully stocked stands is thus from 1 to 2 cords per acre per year of wood such as is often wanted for paper pulp and fuel wood. It will be seen in table 6 that an acre of average land will produce slightly more than a cord a year in stands between the ages of 15 and 50 years; also the highest average rate of production of cordwood comes very early when the trees are not older than 15 years. Most stands are not fully stocked and produce less per acre.

TABLE 5.—*Cordwood (pulpwood, fuel wood, etc.) contained in slash pine trees of various sizes*

Diameter of tree, outside bark, at breast height (inches)	Standard cords in trees [1] having a total height of—							
	30 feet	40 feet	50 feet	60 feet	70 feet	80 feet	90 feet	100 feet
	Cord	*Cord*	*Cord*	*Cord*	*Cord*	*Cord*	*Cord*	*Cord*
5	0.018	0.027	0.037	0.047				
6	.025	.036	.049	.064	0.079			
7	.032	.048	.064	.083	.103	0.120		
8	.042	.060	.080	.105	.132	.151		
9		.07	.10	.13	.16	.19	0.22	
10		.09	.12	.16	.19	.23	.26	
11		.11	.15	.19	.23	.27	.31	
12		.12	.17	.22	.26	.31	.36	0.39
13			.20	.25	.30	.36	.41	.45
14			.23	.29	.35	.41	.49	.51
15			.26	.33	.39	.46	.52	.58
16			.29	.36	.44	.51	.58	.64
17				.41	.49	.57	.64	.71
18				.46	.54	.62	.71	.78
19				.49	.59	.68	.78	.86
20				.53	.65	.75	.85	.94

[1] Standard cord of 128 cubic feet of wood (with bark).

TABLE 6.—*Cordwood yield per acre of slash pine at different ages, in well-stocked stands, or about maximum yields* [1]

Age of trees (years)	Wood with bark			Peeled wood		
	Good land	Average land	Poor land	Good land	Average land	Poor land
	Cords	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*
15	37	27	12	29	20	9
20	46	35	20	35	25	14
25	53	42	26	41	31	18
30	59	48	32	47	37	23
35	66	54	36	53	42	27
40	72	58	40	58	45	30
45	77	62	43	62	49	32
50	81	65	45	66	51	34
55	84	67	47	68	54	36
60	86	69	48	71	56	37

[1] Includes the wood from all trees 4 inches and over in diameter.

The number of trees at any given age required to cut a cord can be easily calculated from the last column of table 1. For example, at 20 years of age on average land, fully stocked slash stands contain

about 150 trees per acre. If the stand on average land at that age cuts about 35 cords (column 3 of table 6), the average tree will cut out about one-fifth of a cord, or it will require about 5 trees to make a cord

How much saw timber will an acre of slash pine produce?

The owner or the prospective buyer of timberland should know its capacity for producing timber. Fortunately, the amount of slash pine timber that can be grown per acre can be predicted because of studies which have been made of many well-stocked, well-set, or dense stands. Table 7 shows the amount of saw timber that stands may be expected to cut at various designated ages. The figures do not include the timber removed in previous thinnings, or the intermediate yield, often a very considerable amount. It is regretted that the rate of timber production for unburned stands is not known, as it would be somewhat larger.

An acre of average-grade land well set in slash pines—for example, 30 years old as shown in table 7, column 3—should cut out an average of 11,800 board feet if all the trees measuring 7 inches and over are carefully sawed. This, in round figures, is an average growth of 400 feet a year. If the logs were scaled by the Doyle rule and only the trees that measure 9 inches and over in diameter at breast height were counted, the timber on the acre would scale only about 1,500 board feet. But the scale shown by the Doyle log rule is too low, and the cut would actually be more.

TABLE 7.—*Saw-timber yield per acre from full stocked slash pine stands at different ages*

Age of trees (years)	Actual cut by careful sawing [1] (mill tally)			Logs scaled by the Doyle rule [2]		
	On good land	On average land	On poor land	On good land	On average land	On poor land
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
15	4,900	1,400	------	------	------	------
20	9,500	3,600	450	1,000	------	------
25	15,800	7,200	1,800	3,500	------	------
30	21,700	11,800	3,600	7,000	1,500	------
35	26,700	15,800	5,400	11,000	3,500	------
40	31,200	19,900	7,700	14,500	6,000	500
45	34,800	23,100	10,000	17,500	8,000	1,500
50	37,100	25,300	11,800	19,500	10,000	2,000
55	39,400	27,600	13,100	21,500	11,500	3,000
60	41,200	29,000	14,500	23,000	12,500	3,500

[1] All trees 7 inches d. b. h. and over, per acre, International rule, ¼-inch saw kerf.
[2] All trees 9 inches d. b. h. and over, per acre, Doyle log rule.

Slash pine, when grown in well-set or dense stands and protected from fire, should grow on the lower grades of land, or situations, 1 cord a year per acre, or from 300 to 500 board feet. Such well-set and protected stands on average to good-grade lands should produce up to 2 cords an acre a year, or from 500 to 800 board feet. Such stands of natural origin are not common. Planted slash pine stands under protection and management quite commonly are producing timber at these rates.

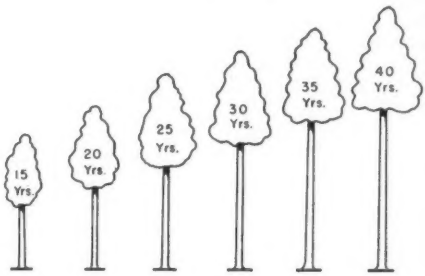
At 40 years a fully stocked acre of slash pine (table 7) on good land should cut about 31,200 board feet, an average of 780 board feet a year; on average land 19,900 board feet, or an average growth of

about 500 board feet a year; and on poor land about 7,700 feet, or an average yearly growth of 192 board feet (fig. 21). These illustrate well the wide differences in growth due to different conditions of soil, soil moisture, and climate. Conditions often vary widely in the same locality.

A caution here is advisable. These figures show what would be the yield if all the trees were sound and straight. A slight allowance for seen and unseen defects in the logs is necessary, or the scale will be somewhat too high.

What are some examples of stands actually measured?

The following essential facts concerning a few of the stands actually measured will serve as an illustration of what yields per acre may be



AVERAGE						
HEIGHT OF TREE (feet)	39	48	56	63	69	79
DIAMETER, breast height (inches)	7	8	9.5	10.5	12	13
CORDWOOD PER TREE (with bark)	0.05	0.08	0.13	0.17	0.26	0.31
CORDWOOD PER ACRE (with bark)	27	35	42	48	54	58
BOARD FEET PER TREE	9	20	42	66	105	133
SAW TIMBER PER ACRE (board feet)	1,400	3,600	7,200	11,800	15,800	19,900

FIGURE 21.—Average size of slash pine trees, their contents in cords and in board feet, and the amount of cordwood or lumber per acre at various ages. (See tables 1, 4, 5, 6, and 7.)

expected from well-stocked slash pine stands, such as are locally considered to be dense stands.

(1) A 21-year-old stand, consisting of 384 trees per acre, averaging 8 inches in diameter at breast height and 56 feet in height, contained 45 cords of wood with the bark on, or 34 cords of peeled wood. If all trees measuring 10 inches and over in diameter were cut, the stand would saw out about 6,400 board feet; or if all trees 8 inches and over were taken, it would saw about 10,300 board feet. By the Doyle log rule, however, all trees measuring 8 inches and up in diameter would scale only 3,700 board feet. This was on good land, giving about maximum yield.

(2) A 25-year-old stand, with 274 trees per acre, averaging 63 feet in height and 9 inches in diameter, containing 47 cords of wood with the bark, or 37 cords of peeled wood. The trees 10 inches and over in diameter would saw out, down to small top diameters, about 10,700 board feet per acre; or about 13,500 feet would be obtained if trees 8 inches and up in diameter were taken. If the logs in the trees measuring 8 inches and over in diameter were scaled by the Doyle rule, there would be only 5,800 board feet per acre.

(3) A 26-year-old stand with 754 trees per acre would cut 64 cords of wood with the bark, or 47 cords of peeled wood. There would be a total of only 1,300 board feet if trees measuring 10 inches and up were taken; or 8,000 feet from all trees 8 inches and over in diameter, as compared with only 1,360 feet by the Doyle rule.

(4) A 30-year-old stand, with 114 trees per acre, averaging 11 inches in diameter and 69 feet high, contained 31 cords with the bark, or 25 cords of peeled wood. There would be 9,672 board feet per acre of saw timber in the trees 10 inches and over in diameter, or 10,700 board feet in the trees 8 inches and over in diameter. If scaled by the Doyle rule, the stand had only 5,700 board feet.

(5) A 51-year-old stand, which consisted of 220 trees per acre, averaging 70 feet in height and 9.4 inches in diameter, contained 57 cords of wood with the bark, or 44 cords of peeled wood. The stand would cut out 10,100 board feet from all trees 10 inches and over in diameter, or 14,600 feet from trees measuring 8 inches and over. The Doyle rule gave only 5,900 feet of saw timber.

REFORESTATION BY NATURAL METHODS

The natural restocking of slash pine lands with young growth may be expected to take place satisfactorily whenever enough seed trees are left in logging. Young slash pine rapidly takes possession of old fields, wet lands, vacant lands near towns, and places protected from fire. Such reforestation, however, is not proceeding everywhere as there has been too-heavy cutting in some places and occasional fires (fig. 22).

There are still large areas of practically idle land in the South which should be growing timber. Many owners of small tracts and some owners of large ones are, however, seeking information and are taking active steps toward getting young pine growth to come back on their lands.

Where do the seeds come from?

Seeds come from the cones, or burs, which mature and open in the fall. Each scale bears two seeds in hollows, or pockets, at its base, which may easily be seen upon examining an open bur. However, scales near the tip and base of the bur commonly do not bear fertile seed. The burs start from very small female flowers that have been fertilized by pollen from the male flowers, and they require two seasons to mature. The pines all bear male and female flowers separately, but both kinds on the same trees.

How much seed do slash pines produce?

Slash pine is a somewhat heavy seed producer. Full or heavy seed crops may be counted on at intervals of 2 to 3 years, although some seed is borne almost every year. Well-developed cones, or burs, have been observed on trees 12 years old, but in general trees growing in the open produce seed only after reaching the age of 15 to 18 years. In close stands seed production is usually limited in quantity and begins at a little later age. The seed is small and is provided with a wing by which it is easily carried on moderate winds a distance two or three times the height of the tree or occasionally much farther (fig. 2). As a result the seeds are widely dispersed.

The number of seeds in a pound varies widely but averages about 15,500, approximately 80 seeds in every 100 being fertile. There are about 215 ripe closed burs in a bushel, the average weight of which is

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FIGURE 22.—Natural regeneration of slash pine: *A*, Good stand of slash pine resulting from plenty of seed and protection from fire; *B*, Cutting for pulpwood, leaving no seed trees to restock the land.

about 34 pounds (24 to 45 pounds). A bushel of burs will yield about 1⅓ pounds, or 18,600 seeds, an average of 87 seeds per bur. In size and appearance the seed of slash pine closely resembles that of loblolly pine, with which it is likely to be confused. The wings of slash pine seed are easily removed—more easily than those of any other kind of southern pine.

Can the seed be kept in storage?

Slash pine seed retains its vitality well in storage. The best known storage is to place the seed, after thorough drying, in tight containers and keep it at as low a temperature as can be found, preferably in cold storage at a temperature of about 25° to 35° F. If cold storage is not available, the cans or jars might well be kept in a vegetable cellar or pit. The latter storage is satisfactory for seed kept over the first winter; the former should be used to keep seed for use the second spring after collecting.

When and where do the seeds germinate?

Slash pine seeds, like longleaf, mostly germinate in the fall within a month after they reach the ground. If the seed crop is heavy and the fall rains favorable, as they are every few years, full stands of young trees result. Conditions favorable for protection from fire also account for the abundance of slash pine in moist situations and its relative scarcity on dry soils. The broad margins of bodies of water, grass bogs in swamps, and flatlands likely to be water-soaked for some time are favorite situations for reproduction. Cultivation of abandoned fields disintegrates the underlying hardpan and affords moisture conditions favorable for seedbeds. Young slash pine growing on such fields is commonly termed "old-field" pine. Fires, which fortunately are becoming less common, are still destroying vast numbers of young pines of the different species.

Can slash pine be grown successively as a crop?

With a kind of tree which seeds as abundantly as does slash pine, there is very little difficulty in growing one crop after another on the same land. Two necessary requirements for establishing a young stand are an adequate supply of seed on open ground and protection against fire. Like all the pines, the best production of slash pine comes from having even-aged trees in fairly close stands.

If a stand of pine trees is cut clean, there will be little or no young growth except where the trees are cut in the fall after the ripening of a good crop of seed. Since logging usually breaks up the surface soil the ideal time to cut the final crop or stand of trees would be during the 2 or 3 weeks while the ripened burs are opening in early fall. This would be just ahead of the period of seed germination and establishment of the young tender seedlings. Reference might well be made to the subject as found on page 37.

PLANTING SLASH PINE

The absence of seed-bearing trees on or near heavily cut or burned-over timberland, or worn-out or idle farm land makes it necessary to start young forest growth by planting small trees or sowing the seed on the land. Slash pine is especially well adapted to reforesting lands by planting young seedlings. Young slash pines have taproots and stand transplanting well if ordinary care is taken, as is shown later.

Is direct seeding of land advisable?

Direct seeding is advisable only under special conditions. In wet or crawfish land in the Coastal Plain of South Carolina and Georgia, satisfactory results have been obtained by direct sowing of slash pine seed. Early November sowings have proved more success-

ful than those made in late March or early April. Sowings made with about 2 pounds of seed broadcast in 1-year rough grass, on low, poorly drained lands have given satisfactory stands; also fair stands have resulted from sowing 1 to 1½ pounds of seed, in hoed spots with 10 seeds to the spot and 1,000 spots per acre. A fairly open stand of grass acts as a protection against sun and wind in affording moisture in the air and modifying extremes of temperature. Pine seed should never be covered more than very lightly.

In seed-spotting low wet land a good method is to scatter 8 to 10 seeds on loose soil and press them in with the foot without any, or with only a slight scattering of soil over them. Owners of recently abandoned pieces of farm land can expect satisfactory results from broadcasting 1 to 2 pounds of slash pine seed in the late fall and harrowing them in like a grain crop.

However, the seed-sowing method is regarded generally as uncertain and less satisfactory than the planting of small tree seedlings. If germination is successful, the method requires considerable labor in thinning out the excess seedlings in order to secure a stand of the desired density. If a dry period follows the sowing, germination may be so delayed as to result in a loss of the seed by insects, mice, or birds. This result has been reported as prevailing in the lower parts of the States bordering the Gulf of Mexico.

Direct seeding of slash pine might well be tried on a small scale or experimentally on wet flatlands or low old fields by landowners interested in securing another crop of trees.

Is the planting of small trees a good method of reforesting land?

The planting of small trees is in general practice in the Coastal Plain—the home of slash pine. Slash pine is one of the easiest of all the pines to grow from seed and set out much like setting cabbage or tobacco plants. Successful and extensive plantations of 1-year-old seedlings have been made in the Coastal Plain from South Carolina to Louisiana. In the latter State one lumber company has more than 12,500 acres of hand-planted young slash pine forest.

HOW TO GET PINE SEEDLINGS

How can slash pine seedlings be obtained?

Small year-old seedlings can be dug up in openings or along the edges of old fields near seed trees, or grown in a nursery bed at home, or purchased at nominal cost from the State forestry departments of the various States. Nursery-grown stock on the whole has proved more satisfactory and usually cheaper than wildling seedlings, which often have poor root development. If the acreage to be planted is large, it will probably pay to establish a local nursery and grow the trees. In any case it is advisable to write to the State forester of your State forestry department, or apply to the local county agent for advice and publications on how to get a supply of seedlings, and how to plant them. Applications for seedling trees should be made to the State forester several months in advance of midwinter or early spring—the best times for planting. Your county agent is in a position to assist you in all phases of growing timber as a crop on the farm, as he is in touch with the State extension forester. There are State or United States Department of Agriculture publications on nearly every phase of reforestation available free upon request to your

State forestry agencies, or to the Office of Information, Department of Agriculture, Washington, D. C.

Where can one get slash pine seed?

Pine seed may be collected from the trees or purchased from some of the State forestry agencies or from commercial seedsmen. It is usually an advantage to plant seed grown in the locality or nearby region. Information about crops of slash pine seed will be found on pages 33 and 34.

The seeds ripen and the burs turn brown in late summer or early fall. A good time to begin collecting is when the first bur in the locality begins to open. Another good test of the right time to begin collecting is whether the burs are ripe enough to float on water immediately after picking. The collection period usually lasts from 3 to 5 weeks. Pine seed is most economically obtained from tops of trees felled in logging. The burs should be pulled off and collected in gunny sacks, buckets, or tubs, and later spread out to dry on a tight floor or on canvas or sacking in the sun. In drying weather they will open in a few days, and if stirred or shaken the seeds will fall out. Each seed has a wing, and the mass of seed should be winged by being rubbed over a screen or between the hands and then winnowed in a steady gentle breeze or in a grain fanning mill. Seed with the wings on are unsatisfactory for direct seeding or use in nursery beds.

Commercial prices of seed range mostly from $1 to $3 per pound. In good seed years, supplies of seed may be collected and cleaned at a cost of not more than $2 per pound, if logging operations are under way so that burs can be picked off the tops of trees felled in logging. If the trees have to be climbed in order to gather the burs, the cost may go up to $3 or more per pound. Often the burs can be obtained by paying collectors from $0.75 to $1.25 per bushel, depending on the abundance and ease of collecting. One year, following a tropical hurricane, burs were obtainable in abundance for 50 to 75 cents per bushel. A bushel generally yields from 1 to 1¼ pounds of good seed. Occasionally, in dry years, pine seeds do not fill out well and are of poor quality.

How can one grow pine seedlings?

Most of the various types of nursery beds are well adapted to growing slash pine. A commonly used type consists of an ordinary bed, flat or even with the paths, or slightly raised and bordered by a curbing of 1 by 4 inch boards set 2 inches in the ground, thus holding in the soil. A width of 4 feet is standard for seedbeds (fig. 23). A sandy type of soil is much better than clay soils.

The soil should be worked well in the fall and again in the spring. Acid soils are very desirable, as damping-off fungi are common and thrive in alkaline or sweet soils. On farms the beds should preferably be located near the house, so as to be easily watched and tended, and a supply of water for use during extra-dry spells is desirable, especially during seed germination and summer droughts. All large nurseries must have adequate watering systems.

In early spring seed of good quality should be broadcast evenly on well-prepared beds at the rate of a pound (about 15,500 seeds) to each 144 square feet of seedbed (4 by 36 feet). Or the seed may be

drilled in rows spaced 6 inches apart. At the rate of 60 seeds per lineal foot of drill 1 pound of seed will be enough to drill a bed 4 feet wide by 32 feet long. The goal in seeding is to produce a crop of

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FIGURE 23.—Growing slash-pine seedlings in nursery beds: *A*, One-year-old trees in Georgia State nursery ready for planting. A full stand has about 40 seedlings per square foot, but losses due to insects or disease may reduce the final crop. *B*, Small farm nursery bed of yearling seedlings in northern Florida, being viewed by interested visitors.

about 40 seedlings per square foot (broadcast), or about 20 seedlings per linear foot of drill. This is equivalent to a total of 5,760 per pound of seed sown broadcast (4- by 36-foot bed), or 5,120 per pound sown in drills (4- by 32-foot bed). With less intensive care in the

nursery and seed of lower grade the amount of seed to be sown per unit of seedbed area should be relatively increased by at least one-half pound. Losses may be expected because of infertile seed, fungi, and insects.

After being sown, the seeds are pressed into the soil by a roller, plank, or spade, and then are covered very lightly with sand and a single layer of burlap (gunny sack) or by a medium layer of fine woods litter or pine straw. The material should be as free as possible of weed seed. Sand from stream banks is well suited for use in nursery beds.

How should nursery beds be protected and cared for?

The sown beds should be watched closely, carefully protected, and watered in case of hot, dry weather. The period during the germination of the seed is especially critical, when an adequate supply of water will often mean the difference between success and failure. If a burlap cover is used, it should be removed as soon as the seeds begin to germinate, as the seedlings rise in the seed shells much as do those of cucumbers and watermelons.

Birds, mice, and insects are likely to be pests. A shotgun, traps, and poison are means of fighting these enemies. The period of germination of slash seed is usually 2 weeks or less, so that expensive wire-screened frames over the seedbeds are not necessary. Shading by screens also is unnecessary in a slash pine nursery. Ants sometimes cause much damage but may be controlled by bait poisoning. Moles sometimes cause trouble and may be kept out by encircling the bed with a narrow trench filled with lime, or by sinking a strip of half-inch wire mesh to a depth of 1 foot around the bed. The damping-off fungi are likely to attack the tender stems just below the surface when the seedlings are up to 2 weeks old. Better ventilation and drying of the surface soil is helpful. Acid soils are the best for pine nurseries; therefore never apply lime as a deterrent to this class of injurious fungi.

In parts of Louisiana and Texas a leaf-eating ant often injures or kills young slash seedlings. The control consists of pouring about one-tenth of a pint of carbon disulphide down each hole or opening to the den of the ant colony. A one-quarter-inch hard-rubber hose with a funnel inserted at one end is used. All surface openings are then closed or covered with sod. A gas is formed, killing the ants. The liquid is highly explosive, necessitating great care in handling. The cost is about 3 to 5 cents per opening.

For further information on fighting any pests of the nursery, application should be made to your local State forester or to the United States Department of Agriculture, Washington, D. C.

All weeds should from the start be pulled out when small; otherwise weeding will greatly injure the small pines. Watering during hot, dry spells is very advisable. A dense stand of seedlings such as should be growing in the beds requires much soil moisture. A gentle but thorough watering at intervals is much better than a mere surface wetting every day, and requires less time.

HOW TO PLANT PINE SEEDLINGS

When is the best time to plant pine seedlings?

In December, January, and February, before the buds begin to swell, conditions are most favorable for planting slash pine seedlings.

Late fall planting may give good results if the season happens to be wet and the winter mild, but much injury may be expected during a dry fall and during a severe winter, because of hard freezing and the

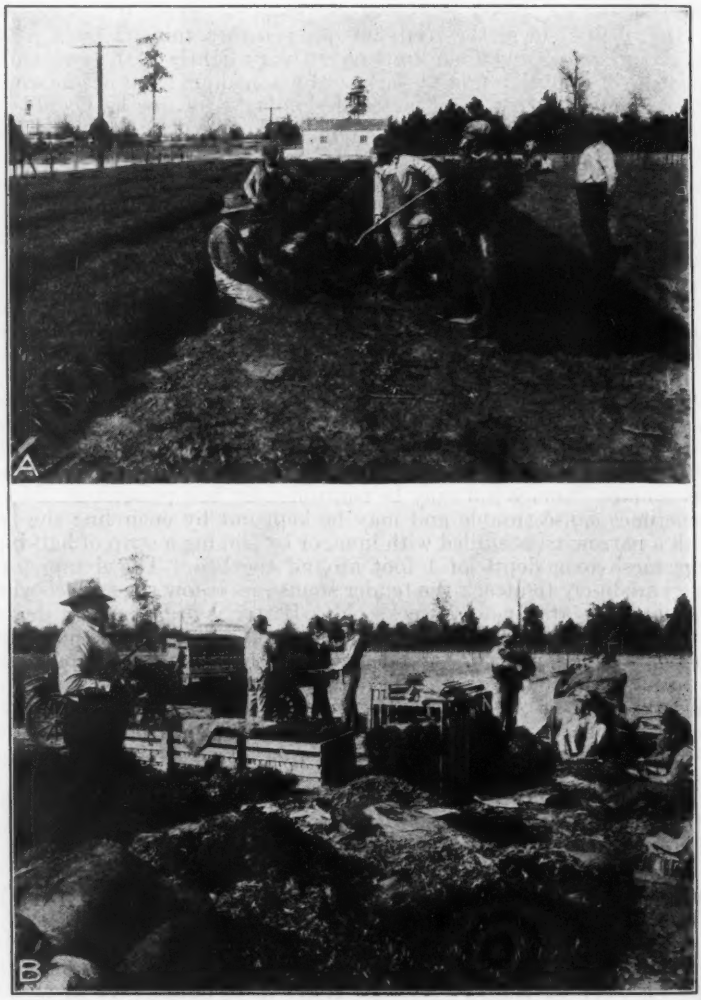

FIGURE 24.—A slash pine nursery of a Louisiana lumber company: *A*, Digging, or lifting one-season-old slash pine seedlings. The soil is carefully loosened and the trees lifted without injuring the roots. *B*, The roots and stems are wrapped in wet sphagnum moss or in burlap, and the bundles are placed in crates for delivery at the planting places. In this nursery 7,000,000 slash pine seedlings are grown.

resulting upheaval of the soil. If planted in the late spring, after the new growth has started, pine seedlings are likely to make a poor growth or die during dry weather.

What are the important steps before planting pine seedlings?

One-season-old slash pine seedlings are best for planting. At the end of one growing season they should be from 8 to 10 inches in height—sometimes higher.

The seedlings should be carefully dug and lifted from the nursery bed in order to avoid as fully as possible breaking the fine rootlets (fig. 24, *A*). All underdeveloped seedlings should be thrown away as culls, since it is an expensive mistake to plant spindling or sickly small trees. The taproot, if over 8 inches long, should be pruned back with a sharp knife. It is of the utmost importance that the roots at all times be kept wet; hence the dug seedlings should at once be placed in tubs or buckets with water, or wrapped in wet moss or gunny sack (fig. 24, *B*). If not wanted at once for planting, the seedlings should be heeled in, in fresh soil, always in a cool, shaded place, and the soil never allowed to dry out. The leaves should be left freely exposed to the air but not to direct sunlight.

The desirability of breaking or preparing the soil for planting small trees depends upon the character of the soil. If the soil is sandy or open, little is gained by plowing. If the land is rough with stumps and bushes, the trees may be planted without soil preparation. If, however, the soil is dense and has an impervious layer, it is well to break it deeply and open it up well in clods. This should be done when the soil is dry, preferably in the fall, some weeks ahead of time to plant the trees. This interval enables the soil to loosen and greatly aids in stimulating early root development.

Plows for use in preparing the soil vary with the conditions. On land that has been in cultivation in recent years, a 6- or 8-inch ripper, or pointed shovel, should be used on the point of the plow stock, and on the heel should be attached a 10- or 12-inch scraper, or wings. On land that has never been broken and is dense, a one-horse or, better, a two-horse turning plow should be used in making a round trip or two furrows. Better preparation is to go one way with a middle-buster and follow with the ripper and scraper on a plow stock, as previously described.

In planting trees, what spacing is best?

Opinion varies widely as to the most desirable spacing to be used in planting slash pines. A natural loss must always be reckoned with, varying usually from 10 to 20 percent. If the trees are planted 6 feet apart in rows 6 feet apart, 1,210 will be required to plant an acre. This is about the largest number of trees that should be planted, and it should allow for thinning out many trees as the stand develops, for pulpwood or fuel wood.

A planting of 1,000 seedling trees per acre would seem to be more desirable. Setting the trees a scant 5½ feet apart in rows spaced 8 feet apart will require 1,000 trees. Or planting them about 6½ feet apart in rows 6½ feet apart will require the same number.

A spacing of 8 by 8 feet, requiring 680 seedlings, has been extensively used in commercial plantings. The practice is now to use more trees, particularly in plantings by farmers, so as to get more wood from thinnings.

In the planting in southern Georgia referred to on page 45, the trees were set 5 feet apart in furrows 10 feet apart, or 870 to the acre. The plan was to turpentine and thin out each alternate tree as soon

as possible, leaving a stand of 436 trees, spaced 10 by 10 feet apart, for future development and working. The 10-foot lanes afforded driveways for the removal of turpentine and timber.

One essential should always be kept in view; namely, when it comes to working the trees for turpentine it is desirable to have frequent lengthwise or parallel openings as driveways, say at least 10 feet wide. These can be obtained by cutting out a row occasionally as required in any of the previously mentioned spacings of plantings. Some advise leaving a 10-foot opening every third or fourth row when planting.

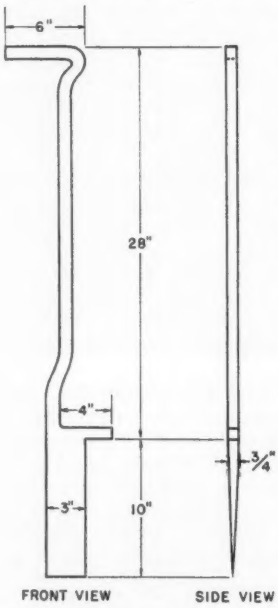

FIGURE 25.—A good kind of planting bar, or dibble, for use in the South for planting small pines. This type is being used rather extensively and with good results. The planting bar is made of two pieces of steel shaped and welded as described on this page.

What tools should be used for planting?

A mattock or a grub hoe is often used to good advantage in planting. Sometimes a spade or a shovel is employed because it is at hand, but neither is well adapted to the purpose. In most soils in the South, planting—which is done in midwinter or early spring, when the soil is moist—can best be done with the use of a planting bar, or dibble. A good planting bar, as shown in figure 25, can be made by forge-welding a heavy, carbon tool-steel blade to a shaft of steel tubing. The blade should be 3 inches wide by 10 inches long and ¾ inch thick at top, hammered to shape, ground to a tapering lower edge, and heat-treated for hardness. A foot pusher is made at the top of the blade, 4 inches in length by ¾ inch in width. The handle is of 1¼-inch (or 1½-inch) tube steel, about 28 inches long, making the tool 38 inches in length. The top of the tube is shaped to a crook and horizontal bar for use as a handle.

Various commercial tool companies make and sell planting bars. Their names and addresses can be obtained upon request from State or Federal forestry agencies.

In using the planting bar a slit is opened, the little tree is held in place by the man or boy carrying the bucket of trees, a second slit is made 3 to 5 inches from the first, and the handle moved away from the first slit so as to pinch the soil tight against the roots. The second slit is closed with the heel of the shoe.

How should pine seedlings be planted?

The essential aim of good planting is to leave the trees tightly set in the ground, at the same height that they stood in the nursery, with the least possible injury to the fine rootlets (fig. 26).

Roots must always be kept moist during planting and spread out in the hole or slit rather than bunched. Afterward the soil should be well firmed about the tree to avoid rapid drying.

One method of planting small pines is for 2 men to work together as a crew—1 making the holes and 1 carrying a bucket of trees and planting them. The bucket should have water, or better, a thin clay puddle. A 2-man crew using a mattock in average sandy soil can plant 1,000 to 1,400 trees a day or, using a dibble and having the work well organized from 1,400 to 2,000 trees. If a mattock is used, the holes are often dug larger than is necessary. They should be dug as shown in figure 27, only a little larger than necessary to spread out the roots in a natural position, with the taproot straight down. The soil is then scraped in about the tree, which should be set fully as deep as it grew in the nursery bed or woods and be well firmed with the foot (sole or heel of shoe) so as to prevent drying out. Some straw, grass, or loose soil scraped about the tree will be helpful in acting as a mulch to prevent too-rapid drying (fig. 28).

Advantage should be taken of favorable weather. Cloudy weather following rains affords ideal conditions. After planting no further attention is necessary, except protecting the trees at all times from fire and from hogs or other injurious livestock.

No livestock should be permitted to run over land set in pines for at least the first 5 years. Watering and cultivating the trees in a forest plantation are both impracticable from a financial standpoint and should not be attempted. The case is different where a few trees are set out for ornamental purposes.

In a forest plantation loss of up to 15 percent of the total number of trees set out is not an uncommon experience. Among the common causes are the poor grade of trees used, careless planting, and drought at the time of planting or soon after. If any considerable loss occurs, it is good practice to reset the blank places the next spring or a year later. The importance of fire protection is discussed on page 46.

COST OF PLANTING PER ACRE

In estimating the cost per acre of planting pine seedlings, much depends upon the size of the operation and the kind of soil and its condition. Experience shows that some farmers have found it cheaper to dig wild seedlings, while many more landowners have found it much better and cheaper in the long run to plant only thrifty nursery-grown stock because of its better root development. Such trees may be grown at home, or in most States they may be purchased from the State forestry commission.

Assuming a cost of $2.50 for a thousand nursery-grown seedlings, 680 trees per acre (spacing of 8 by 8 feet) will cost about $1.70. The cost of his mule team for an hour in furrowing an acre of land will be regarded by the average farmer as a small item. To plant 680 seedlings should take 2 men less than one-half day. The total cost, if the labor is figured at $1.50 per man per day, would amount to from $3.50 to $3.85 per acre, or about $4 if the land is furrowed. This is believed to be a conservative figure. If the spacing 6 by 6 feet is chosen (1,210 trees per acre) the corresponding cost would be about $5 per acre.

With spare hands and teams in winter the farmer may be able to reduce the cost somewhat. Probably the planting of 1,000 seedlings per acre (6½ by 6½ feet) can be done at a total cost of less than $5. Planting cut-over land on a large scale, one lumber concern in Louisi-

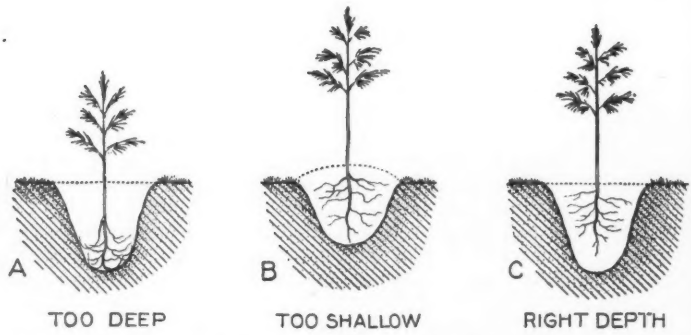

FIGURE 26.—The seedling trees should be set a little deeper than they grew in the nursery or woods as shown in *C*. Doubling up the taproot as in *A*, is extremely injurious, and if set too high, as in *B*, the tree is likely to fall over in a wind or dry out and die.

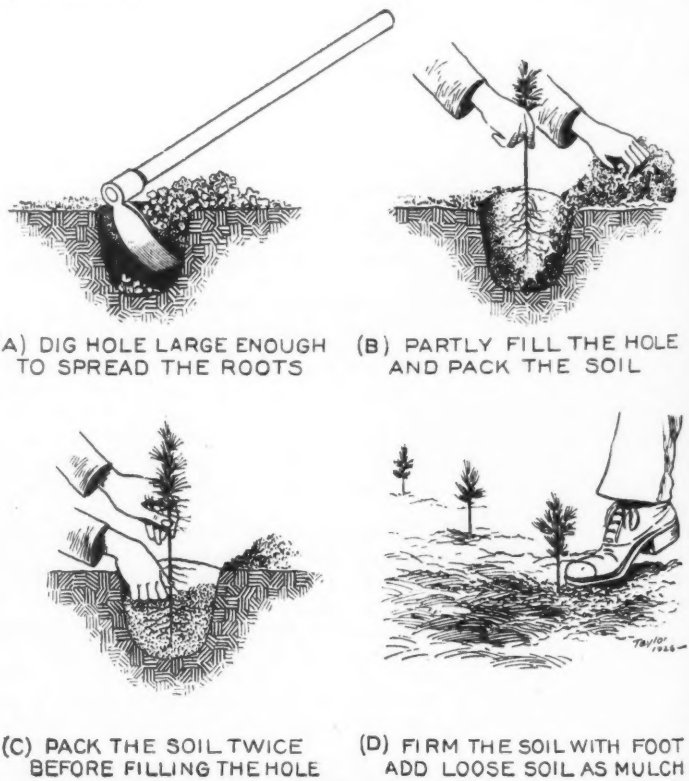
(A) DIG HOLE LARGE ENOUGH TO SPREAD THE ROOTS
(B) PARTLY FILL THE HOLE AND PACK THE SOIL
(C) PACK THE SOIL TWICE BEFORE FILLING THE HOLE
(D) FIRM THE SOIL WITH FOOT ADD LOOSE SOIL AS MULCH

FIGURE 27.—Planting pine seedlings with a mattock or grub hoe in land that has not been treated, except possibly burned to get rid of a heavy rough. Trees may also be planted in this manner in the bottom of furrows in soil that is not loose or not easily wind-blown.

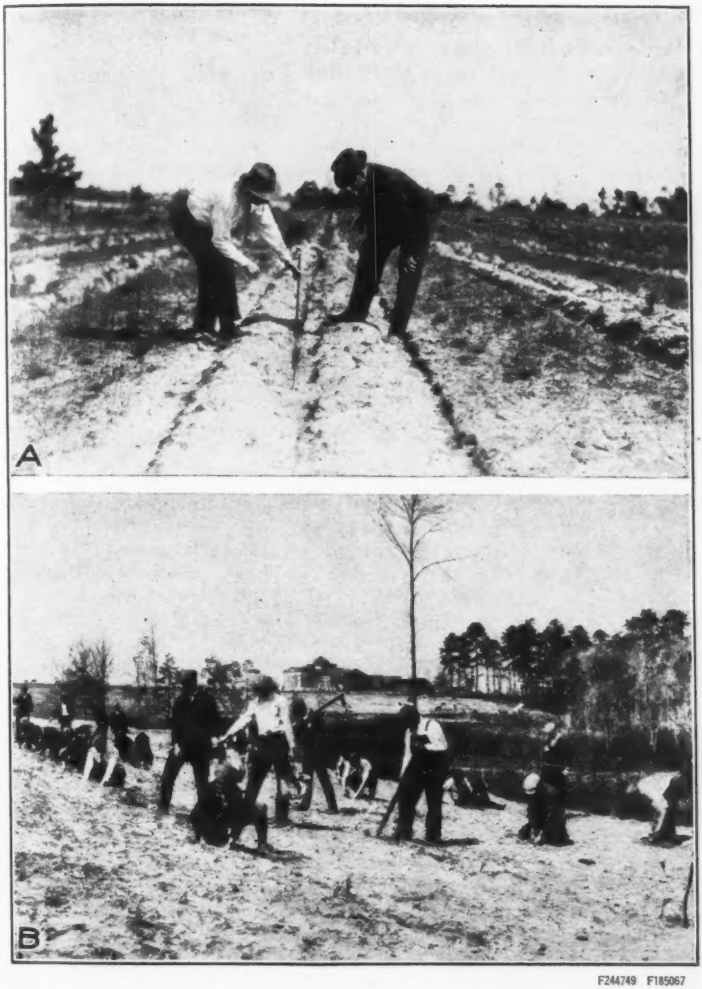

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FIGURE 28.—Methods of planting slash pines: *A*, A scooter-plow furrow followed by two ordinary furrows on the sides affords a very good planting ground, especially in heavy broomsedge fields. The competition from weeds and grass is checked and the danger from fire greatly reduced. *B*, Group of agricultural high-school boys planting poor sandy land on the school farm with slash pine seedlings. The trees were planted with mattocks or spades 6 by 6 feet apart, making a stand of 1,210 per acre—a good spacing on small tracts of land such as about farms.

ana has set out more than 16,000 acres of slash pines at an average cost of about $4 per acre, including all expense items.

Where can slash pine be planted safely?

Within its natural range slash pine may safely be planted except in deep sterile sands and very wet lands.

Small plantings or plantations of a few acres each have been made in many places in eastern North Carolina, in South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and southeastern Texas, and some in western Tennessee. Figure 29 shows a representative farmer's plantation.

It has recently been observed that a rust canker (p. 50) is affecting the small seedlings in nursery beds and larger trees in the woods. This disease is most threatening in the western part of the natural range, including Mississippi and Louisiana. Slash pine may be extended by planting, apparently with a fair degree of safety, north of its range in South Carolina, Georgia, and eastern Alabama, but elsewhere it should be planted only on a very limited or experimental scale outside its range.

Large plantations of slash pine have been established in the deep South by farmers, lumbermen, large land-holding concerns, and one or more trunk-line railroads (fig. 30). The development of a large slash pine plantation and estimated returns are illustrated and described on pages 52 and 53.

The high cost of turpentining stands of widely scattered trees points clearly to a day when turpentining can be done profitably only in stands of good density or stocking. Planted stands promise to enter in a large way into the future production of naval stores. Already, planted stands are being very profitably worked for turpentine in southern Georgia and in Florida.

PROTECTION OF THE TREE CROP

Is woods burning harmful?

The damage and loss to slash pine caused by fire is enormous and ranks along with that caused by heavy and wasteful cupping. Both these causes of injury are man-made and of all the sources of injury can be most readily controlled.

The yearly burning of the woods, still practiced in some parts of the natural home of slash pine, has been done with little realization of the enormous damage to the timber and forest land and of the money loss to the owner.

If southern pinelands have seed trees and are protected from fire, young growth will generally spring up in sufficient abundance for a new crop. Young pines that are afforded protection from fire grow rapidly and create wealth. Protection of the cut-over lands from fires (fig. 31) would mean in a relatively short time the turning of millions of acres of idle lands into profitably growing crops of turpentine and timber.

Fire protection, although very desirable throughout the life of slash pine, is particularly so during the first 3 to 5 years of the life of seedlings. The rapid growth soon takes the sapling above the hottest fire zone, which occurs just above the dense grass. In this respect slash closely resembles loblolly pine but differs widely from longleaf pine. Although trees that have attained heights of 3 to 6 feet are

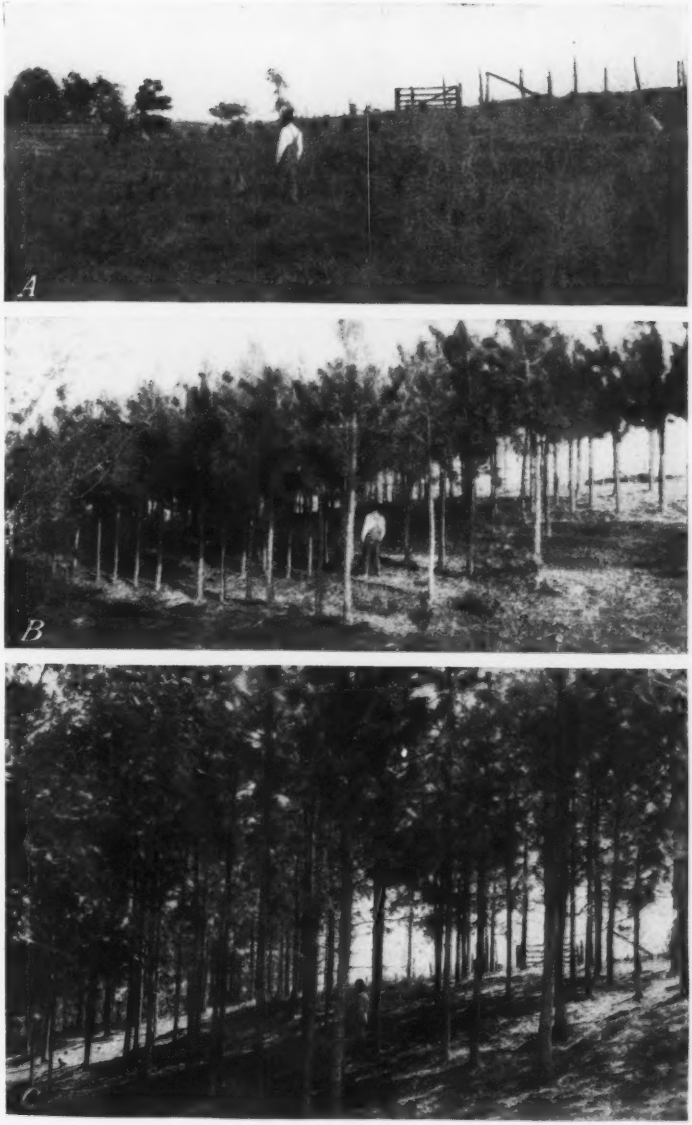

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FIGURE 29.—For 9 years this farmer hoped that pines would "take" this worn-out and idle hillside near his home in central Mississippi. Then he set slash pine seedlings, 8 by 8 feet apart, or 680 to the acre: *A*, Trees, 1 year after setting; *B*, same stand 5 years later; *C*, same stand 10 years after setting, age of trees, 12 years from seed. The farmer has cut and used fuel wood and sold pulpwood in thinning out the poorer trees.

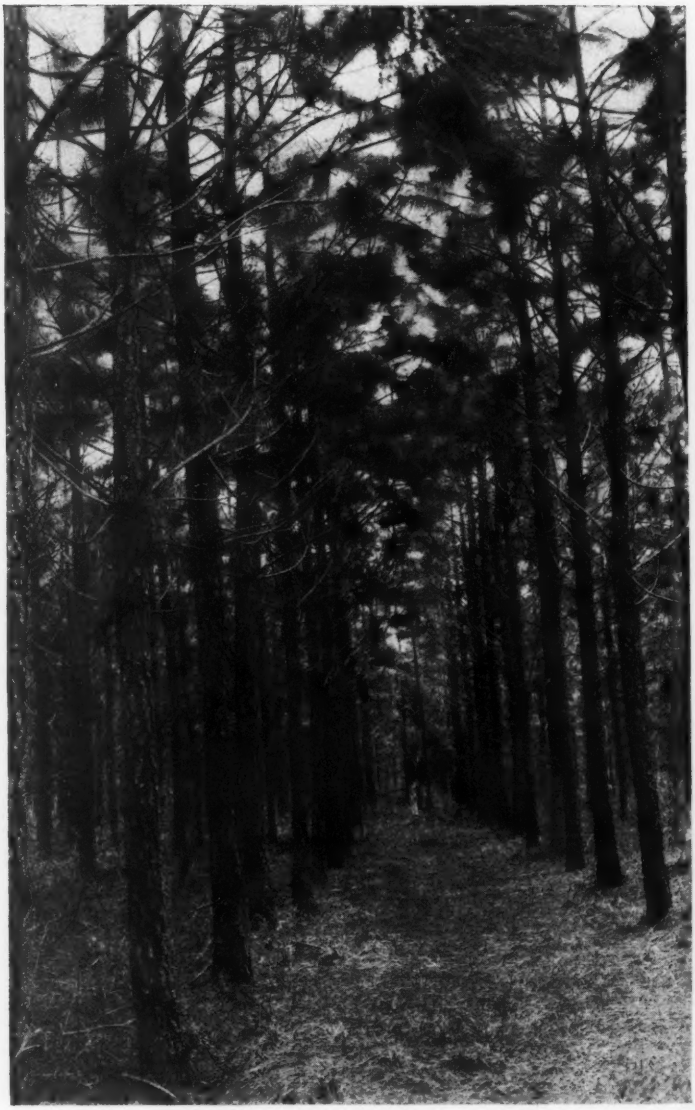

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FIGURE 30.—Slash pine 10 years after planting in a heavy broomsedge old field in South Carolina. The trees are 35 feet in height and 6 to 8 inches in diameter. Soon the trees 9 inches or over in diameter can be worked for turpentine. A second pruning can now be profitably made in order to produce clear, high-grade timber. (Forest owned and managed by a trunk-line railway.)

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FIGURE 31.—Fire is a serious menace to young pines: *A*, A fire burning at night was stopped by this woods road which is covered with carpet grass, closely grazed. All young trees on the left were killed. Across the road is a full stand of thrifty sapling slash pines. The practice of establishing carpet grass in firebreaks for grazing as a means of better protection is increasing. *B*, Two furrows thrown together make a cheap and effective firebreak in the wire-grass country for stopping a slow fire or for use in backfiring. A disk plow and tractor are used.

injured and sometimes destroyed by slow or "cool" fires, enough trees generally remain to produce a fair stand. Stands of pine which have not passed through repeated fires are fortunately becoming more numerous.

Fire damages and weakens mature trees, making them easy prey for insects and wood-rotting fungous diseases, or so-called punks. Trees weakened by fire are easily wind-thrown, and this causes the loss of large amounts of pine timber (fig. 15). Every year millions of young pine trees, the foundation of the future forest income, are killed by fire. Other millions of young saplings are defoliated and otherwise injured, and stunted in growth. The period of growth required to reach merchantable sizes is thus lengthened and the financial returns decreased.

Pine timber grows rapidly when the trees are given enough growing space and kept from harm by fire. (See pp. 8 and 12.)

What damage is caused by insects?

Outbreaks of the southern pine beetle occur occasionally, but nearly always during years of extreme drought or locally in places where little rain has fallen for 2 or 3 months of the growing season. It is important that close watch of pine stands be kept during unusually dry periods. The adult is a small dark-brown beetle. In the soft inner bark of the tree it lays eggs which hatch into grubs, often known as worms. These feed on the rich, living layer of inner bark and new wood, thus girdling the tree and causing its death. The life history of this insect is known, and information regarding measures for checking its depredations can be obtained from State entomologists, or from the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D. C.

The pine sawyer is a large beetle whose larva, a white grub, bores into the sapwood of dead or felled timber. Its activity may be checked by peeling and drying the timber or immersing it in water.

Young slash pine seedlings are only occasionally injured by the Nantucket tip moth, which attacks the tender young shoots in the early summer. It is rare to find the shoots killed by this or any other insect. If so attacked, the tree becomes somewhat deformed, and its rate of growth is slowed up. Most trees successfully outgrow the attack.

Are pine trees subject to diseases?

If uninjured by fire or other agencies, slash pine, until an advanced age, is not seriously affected by "red heart" or other fungous diseases. Wounds caused by fire admit the spores or "seeds" of fungi, but as a rule the vigorous young trees are able to combat them successfully. Probably the antiseptic qualities of the crude gum help in this matter. After the tree reaches an advanced age red heart is likely to become an enemy, sometimes eating away the heartwood and thus weakening the tree, as well as destroying the value of the affected wood. The best protection is to keep out all fires, and cut and utilize the trees as soon as they show the bumps, which are good indications of the presence of disease.

A rust canker disease [7] has been spreading over parts of the South infecting various species of pines. It causes an unnatural sprouting and deforming wounds on the stems, branches, and small trunks of

[7] *Cronartium fusiforme*, or another closely related rust canker.

trees. The other species of rust causes rounded nodules on the stems or trunks. The rust disease is showing up in some forest-nursery operations. It is threatening to become serious, and studies attempting to mitigate the disease are under way. The alternate host of the rust is known to be various species of oaks. These are being cleared off in the vicinity of large nurseries.

PROFITS FROM SLASH PINE STANDS

The financial returns from second-growth pine on the farm or small holding are not difficult to determine if fire, the chief source of damage and loss, is absent. Under fire prevention or control the

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FIGURE 32.—Slash pine ranks as the fastest-growing pine in the South up to about 20 years of age. On old fields its growth is often extremely fast. At 13 years of age this stand is being worked for turpentine with 104 trees per acre, bringing the owner $10.40 per acre. In addition there were 524 trees per acre left for future working. This stand represents about the maximum rate of growth and yield of products for the age.

lands naturally restock without expense, and the timber growth is rapid. A very favorable situation on many farms is that second-growth pine from 20 to 40 feet in height already occurs, sometimes covering a considerable part of the farm. If the timber is slash pine, it will be merchantable for turpentine, ties, pulpwood, and firewood at ages of from 20 to 30 years, yielding from 12 to 60 cords of wood per acre (fig. 32). Older stands, from 30 to 40 years of age, yield saw timber at the rate of 7,000 to 18,000 board feet per acre. Thus slash pine affords a choice of two sources of revenue. The value of young growth is being realized more and more as utilization includes smaller and smaller sizes of timber. Under these conditions, obviously, only a comparatively few years are required for rapid-growing kinds of trees to become merchantable.

LANDS RESTORED TO PRODUCTIVE USE

A large lumber company in southern Louisiana in the winter of 1924–25 planted slash pine seedlings on 1,000 acres of its cut-over land, part of about 30,000 acres that were planted. The land had been held for sale for many years, but no buyer had appeared. The planting cost was $4 per acre. The growing stand is shown in figures 33 and 34. When the trees were 12 years of age the owners cut 6 cords of pulpwood per acre, worth $1 per cord stumpage, and left 18 to 20 cords per

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FIGURE 33.—Slash pine seedlings were planted 8 by 8 feet apart, or 680 trees to an acre, on 1,000 acres of cut-over pineland in January and February 1925, by a lumber company in southern Louisiana. This picture shows the trees when 5 years old, at a height of 8 to 12 feet. (See also fig. 34.)

acre, as shown in figure 34*B*. The estimated later returns from timber up to the age of 30 years are summarized as follows:

TIMBER PRODUCTS

Original investment: Land, $3 per acre; cost of planting, $4 per acre; or a total investment of $7 per acre.

At the end of 12 years: Original investment carried at 4 percent and yearly taxes and protection at 15 cents brings the gross investment to a total of $13.45. Pulpwood sold ($6) reduces the net investment to $7.45.

End of 18 years (estimated): The net investment, carried at 4 percent, and a yearly carrying charge of 15 cents per acre, make the gross investment $10.41. Pulpwood to be sold ($6) reduces investment to $4.41 net.

At the end of 24 years (estimated): The net investment, carried at 4 percent, and yearly carrying charges of 15 cents per acre make a gross investment of $6.57. Pulpwood to be sold (6 cords at $1, or $6), and sawlogs to be sold (8,000 board feet at $5, or $40) makes a net profit of $39.43.

At the end of 30 years (estimated): Figuring the annual carrying charge of 15 cents per acre for protection against the sale of 10,000 board feet of sawlogs at $5 per thousand or $50, makes the total net profit $88.44 per acre from wood products.

TURPENTINE PRODUCTS

Working the trees for naval stores provides additional income. For this purpose it is assumed that 200 trees per acre (9 inches or over in diameter) will be worked for two 5-year periods, or 10 years, during the age period of 15 to 30 years. This will include cupping and back-cupping. At an estimated lease price of 4 cents per face per year an income of $80 will be derived.

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FIGURE 34.—Later views of the slash pine plantation, shown in figure 33: *A*, Two years later, or 7 years after planting; *B*, 6 years after the picture *A* was taken, or 13 years after planting. One year before picture *B* was taken 6 cords of pulpwood per acre were cut by taking out the least promising trees, leaving the straightest and fastest growing for later harvests of pulpwood and sawlogs. The large stumps are from the original logging of longleaf pines. Recent stumps are hidden in the grass.

TOTAL INCOME

Adding the return from turpentining to the profit from wood products gives a total of $168.44 per acre as the net income, or an average of approximately $5.60 per acre per year over the 30-year period.

TURPENTINE AND TIMBER RETURNS

Land of average quality that is well stocked with slash pine may be expected over a period of from 10 to 25 years to yield a net yearly income from crude gum of from $5 to $10 an acre. During this time, and especially following the working, the stand should yield a very considerable revenue from the sale of the timber for poles, sawlogs, pulpwood, cross ties, or fuel wood. This should materially increase the average yearly return.

Open-grown slash pine, on average situations, may be expected to produce in 40 years a merchantable log 40 feet long, measuring 10 inches at the top by 18 inches at the butt and containing 270 board feet of lumber.

Slash pine grows rapidly in dense stands and, at from 15 to 25 years of age, yields large amounts of crude turpentine. After liberal deductons for taxes and fire-protection costs during the period have been made, concrete examples of well-stocked stands of young growth show profits of from 8 to 12 percent compound interest on an investment of $5 an acre.

Crude gum, leased for working in the standing tree, has long been looked upon in the South as a standard farm product. In many sections of the South farmers are cupping their timber and selling the gum to the local stills. After trees reach 9 inches in diameter, cupping them for turpentine is extensively practiced. In closely grown slash pine stands this size corresponds to ages between 20 to 30 years on good soils and 35 to 50 years on unfavorable situations. Open-grown trees reach this size at ages of from 15 to 25 years. Many farmers and other small timber owners have derived a good profit from selling the turpentine rights to operators of stills for 4 to 6 cents per year for each face or cup for a period of 4 or 5 years' working. When carefully turpentined for a period of from 4 to 12 years or more, including resting intervals, and then turned into poles, piling, or lumber, slash pine can be handled on short rotation or at an early age with good profit.

The demand for timber to be used in making pulpwood, ties, poles, excelsior blocks, and stave wood indicates good markets hereafter for small-sized timber. New paper mills, each requiring from 100 to 500 cords of wood daily, are being established in the South in regions not already fully covered by similar mills. The pulpwood in many instances is drawn from locations 100 miles from the mill. Lumber of smaller and poorer grades is being used each year in increasing amounts, and the higher grades are relatively difficult to find and high-priced (fig. 35). These factors point toward the profitable growing of crops of slash pine with resulting benefit to the landowner, the community, and the State.

There is plenty of land on farms for growing timber as a crop after all the better lands are used for other farm crops and for pastures.

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FIGURE 35.—Slash pine in its virgin haunts. In the original forest, slash pine was confined to poorly drained flatlands, but since the cutting of the virgin forests it has spread widely over much of the region formerly dominated by longleaf pine.

No farmer can afford to pay taxes on idle land. Forest conservation on the farm has come to be a matter of economic necessity.

Forests, unlike many natural resources, can be used and regrown forever. Continuous production of tree crops on lands best suited for the purpose is the aim of forestry.

Since timber and wood are required for the successful operation of the farm and since most farmers have some lands best adapted to tree growth, the growing of timber as a crop is legitimately a part of the farm program.

FURTHER INFORMATION

The State foresters, most of whom are located at the various State capitals, and the State extension foresters of the various State colleges of agriculture are in a position to furnish further information regarding slash pine in their respective States. Farmers should consult their local agricultural county agents, who are now dealing with forest trees as a farm crop. These agents are in close touch with the State extension forester and have for distribution various publications on the subject of tree farming. Requests may also be addressed to the Office of Information, United States Department of Agriculture, Washington, D. C.

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